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# CLEAN COAL TECHNOLOGY PROGRAM

## HEARINGS

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON THE

CLEAN COAL TECHNOLOGY PROGRAM INCLUDING THE DEPARTMENT OF ENERGY'S FISCAL YEAR 1988 BUDGET REQUESTS FOR CLEAN COAL TECHNOLOGIES

APRIL 2 AND 9, 1987

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# CLEAN COAL TECHNOLOGY PROGRAM

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THURSDAY, APRIL 2, 1987

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
*Washington, DC.*

The subcommittee met, pursuant to notice, at 9:30 a.m., in room SD-366, Dirksen Senate Office Building, Hon. Wendell H. Ford, presiding.

## OPENING STATEMENT OF HON. WENDELL H. FORD, A U.S. SENATOR FROM THE STATE OF KENTUCKY

Senator FORD. I would ask that the meeting come to order.

I have a short statement I wish to make, and then we will proceed. There will be votes on the Senate floor starting not too long from now, hopefully; and I want to be able to be there so as not to disrupt the hearing.

It is my pleasure today to open a set of hearings to discuss the status of the Clean Coal Technology Program. The Clean Coal Technology Program was established to promote the use of our nation's most abundant energy resource, coal, and to do so in an environmentally sound manner. Needless to say, I think these are both very admirable goals.

At today's hearing, we hope to learn more about the clean coal technologies themselves, when we can expect commercialization to begin so that they can begin reducing emissions, and about some of the barriers to commercialization of the technologies. At next Thursday's hearing, on April 9, we are looking forward to hearing from DOE about their progress in clean coal so far and about the President's recent proposal. We also plan to hear from the National Coal Association and the American Mining Congress.

Originally, the Department of Energy resisted the idea of a federal clean coal program. I quote from a May, 1985 report which says, "Federal incentives will not accelerate commercialization of these technologies and may be counterproductive to their development."

And then they dutifully administered the program that Congress, via an appropriations act, directed them to do.

We are pleased about that.

We are also very pleased to see contracts signed for the first two of the nine projects selected in Phase I of the first clean coal solicitation. We are looking forward to seeing the remaining seven go forward.

Lately the Administration seems to have gone further in its support for clean coal. We were pleasantly surprised by DOE's complete turnaround. We can only speculate as to what might have caused this change.

In any case, we are pleased about getting DOE on our side; that is, in favor of advancing new clean coal technologies.

Unfortunately, not many details about their $2.5 billion five-year program are available. But as I said earlier, we are looking to learn more from Assistant Secretary Wampler next week. We are also hoping to hear about President Reagan and Prime Minister Mulroney's upcoming meeting in Canada this weekend.

Support for clean coal technology comes from another and more likely source: the Distinguished Senator from West Virginia, Senator Byrd. On Monday, March 30, Majority Leader Byrd introduced S. 879, the "Clean Coal Technology Deployment Act," to hasten the development and commercial deployment of innovative clean coal technologies.

We are glad to have such an important piece of legislation, Mr. Leader, on the table. The full Committee will schedule a hearing at a later date to give full consideration to this most appropriately timed bill. We are looking forward to hearing Senator Byrd's testimony this morning.

Senator Byrd, we look forward to hearing from you.

## STATEMENT OF HON. ROBERT C. BYRD, A U.S. SENATOR FROM THE STATE OF WEST VIRGINIA

Senator **Byrd**. Thank you, Mr. Chairman.

The Senate, as you have indicated, goes in at 10:00. I, therefore, am going to have to cut short my testimony. I would ask that the full statement appear in the record, together with the supporting materials.

Senator **Ford**. Senator Byrd, they will be included in total.

Senator **Byrd**. Mr. Chairman, for many years I have been promoting and encouraging the development, demonstration and commercial utilization of clean coal technologies. These technologies will ensure a future of abundant, secure energy supplies at reasonable cost.

I also believe that the long-term development and commercial deployment of these promising technologies will assure us of steady progress toward resolving the acid rain problem.

The Federal Clean Coal Technology Program, a program that I have promoted and which has enjoyed strong bipartisan support in both Chambers, holds the promise of allowing us to continue use of our most abundant fuel source—coal—in an environmentally safe, cost-effective manner.

But the current Department of Energy Clean Coal Program is only the first step toward widespread commercial application of these technologies.

On Monday, as you have indicated, Mr. Chairman, March 30, I introduced S. 879, a bill that would take us another step closer to the widespread commercial use of emerging clean coal technologies.

The Clean Coal Technology Deployment Act would provide financial and regulatory incentives to the electric utility industry and others to construct initial risky commercial-sized clean coal technology projects.

The deployment success of such projects will foster the financial and regulatory certainty that is a prerequisite for future commercial applications of innovative technology.

This bill is needed because, while the current clean coal program is designed to provide industry with technical and economic information for smaller, demonstration-scale projects, there is still a serious need to address the regulatory and financial risks associated with the early commercial use of a new technology.

Companies are always risk averse, but regulated firms, such as electric utilities, are particularly wary of taking the technological risks. This proposal, through financial incentives and the removal of some regulatory impediments, will "buy down" those risks and will encourage utilities and others to deploy clean coal technologies that have been tested at a less-than-commercial scale.

This clean coal technology bill provides $3.5 billion over ten years to assure the commercialization of these emerging technologies. I believe it is a wise investment that will clearly more than pay for itself in the long run.

Consider the fact that the U.S. will require 100,000 to 200,000 megawatts of additional new capacity this century. Much of this new capacity will be coal-fired. Environmental concerns over the use of coal to provide this additional capacity require that we develop ways to burn coal more cleanly.

New clean coal technology now under development could reduce the cost of this necessary capacity expansion by more than 50 percent relative to current experience.

Both industry and government analysts agree that a deployment program would result in these technologies being available five to ten years earlier than would otherwise be the case.

Thus, the current Clean Coal Program and this proposed deployment program are essential to meeting our projected increase in electricity demand in an environmentally acceptable, cost-effective manner.

Since 1980 Congress has been debating what should be done about the acid rain emergency. For a decade we have been warned that without immediate and drastic control measures, our lakes and forests would be faced with impending doom.

Fortunately, in 1980 Congress put into place a massive acid rain research program. While the debate has raged, scientists have been carefully performing experiments and gathering information.

The results will not be fully completed until the end of the decade. The information gathered thus far indicates that there is no reason to believe that the problem demands immediate and drastic action.

The important thing is to achieve steady progress in reducing emissions. Immediate massive reductions are not scientifically defensible.

I am deeply concerned, as I know you are, Mr. Chairman, about the environment. I believe that coal should be burned cleanly and efficiently. I am also deeply concerned about job stability and the welfare of communities in states such as my own.

I worry about the competitiveness of our energy-intensive industries and about the electric bills that residential, commercial and industrial consumers must pay. Because acid rain is not an emergency, I believe that none of the acid rain control bills introduced to date has found the appropriate balance between environmental quality and economic impacts.

These bills require major sacrificies in the livelihoods of millions of our citizens to improve environmental quality for others.

Perhaps I would not demand as much scientific certainty on the impacts of acid rain if the impacts of proposed regulatory bills were not so severe. But severe they are, indeed.

These bills would not only be expensive, socially disruptive and injurious to our competitive position, but they could also harm the environment in the long run. The time and money that could be spent developing and deploying newer, cleaner coal technologies would instead be diverted to costly and inefficient retrofitting equipment in order to meet the requirements that these bills would impose.

Many of the clean coal technologies now under development can do better than the current new source performance standards for both sulfur dioxide and nitrogen oxide.

Currently proposed acid rain legislation will achieve near-term reductions, but it will do so only at the expense of the long term. Continuing with the current clean coal program and establishing a deployment program to assure the commercial adoption of emerging clean coal technologies makes better sense in the long term—better economic sense, better environmental sense, and better energy policy sense—than adopting an acid rain bill with only near-term environmental benefits and tremendous costs.

While there is strong disagreement over the need for proposed acid rain legislation, there is a growing consensus that clean coal technologies afford us steady progress toward reducing emissions.

The Federal Government should continue its commitment to the development of these promising technologies and should adopt a deployment program that will assure their commercial use as quickly as possible.

With the enactment of the Clean Coal Technology Program, the Congress took a bold step in ensuring the timely development of a range of technological options for the clean use of coal.

The availability of such options is important for the planning and construction of power plants to provide new electric generating capacity to meet the nation's future energy needs.

Of equal importance, electric utilities considering whether to make capital investments to extend the life of existing generating facilities, will have a variety of technologies from which to choose.

Finally, for energy-intensive industries, such as steel and aluminum, improvements in the production of energy through the use of clean coal technologies can contribute to the enhancement of the competitiveness of such industries in international markets.

As our understanding of acid rain science evolves, we may decide that a retrofit program is warranted. If that were to happen, the availability of innovative technologies could reduce compliance costs by as much as 50 percent when compared to existing scrubber technology.

A 50-percent reduction in compliance costs could make an enormous difference in hard hit states, such as West Virginia.

I hope that the Senate will take the next bold step to assure that once developed, these technological options for clean use of coal are commercially deployed by the private sector.

Unfortunately, the Federal Government cannot risk bowing out during any step in the process of developing these important technologies. The costs to our environment, our economy and our industrial competitiveness are just too great, should we allow these technologies to be shelved.

I take great pleasure in being able to report that the Administration which at one time staunchly opposed my clean coal program is now one of the program's strongest advocates.

In its budget request for fiscal year 1988, the Administration requested a significant increase in funding for the program over the next several years. Two weeks ago, the Administration committed to funding the recommendation of the Joint Report of the U.S.-Canadian Special Envoys. The President vowed to seek $2.5 billion for the demonstration and deployment of clean coal technologies.

I support the administration's efforts to fulfill our commitment to Canada. I hope that Canada will also fulfill its commitments.

Although there are some important distinctions between this bill and the Joint Envoys' Program, I believe that there is enough overlap and compatibility that we can work with the Administration to achieve both sets of goals.

I have attached a side-by-side comparison of my bill, the Administration's proposal and the Drew Lewis recommendations. The bill that I have introduced presents a program that is longer term and more broadly conceived than that of the Joint Envoys.

The Joint Envoys' program is limited to retrofit technologies on sources that affect Canada. The program and the legislation I introduced would fund both retrofit technologies that could achieve near-term emission reductions, as well as new advanced technologies that will power America's next generation of plants.

The legislation I introduced would provide for $3.5 billion over ten years, or $350 million per year. The President's program would spend $2.5 billion over five years, or $500 million per year.

I believe that a lower rate of spending over a longer time period is preferable for two reasons: One, its lower immediate budgetary impact; and, two, the lessons learned from the early projects can be applied to the later projects.

The Administration's program would be limited to technologies that could be selected today. The program that I am sponsoring would include technologies that could be selected tomorrow.

This is one issue in which I take much pride in now being on the same side as the Administration. With the President's shared commitment to the development and deployment of clean coal technologies, I feel certain that together the Administration and Congress can craft a productive national clean coal program.

Together, we can safely expand the use of coal to power our nation's economic growth. Together we can ensure that we will have long-term domestic supplies of clean energy. Together we can move to the forefront of the development of clean coal technologies for domestic, as well as international markets.

And together we can develop a program that will improve the environment while making America more competitive both technologically and industrially.

These are noble national goals that can only be achieved with continued bipartisan support in Congress and the continued support of the President.

The Administration has recognized the need for further federal involvement in the development of clean coal technologies. The ever-increasing importance of rapidly incorporating these technologies into the commercial marketplace has been underscored.

Enactment of S. 879 will assure that these promising new technologies are commercially available as quickly as possible to allow us to continue to use our most abundant fuel source—coal—in a clean, cost-effective manner.

Mr. Chairman, that completes my prepared statement.

[The prepared statement of Senator Byrd follows:]

# TESTIMONY OF SENATOR ROBERT C. BYRD

BEFORE THE SENATE SUBCOMMITTEE

ON ENERGY RESEARCH AND DEVELOPMENT

ON S. 879

## THE CLEAN COAL TECHNOLOGY DEPLOYMENT ACT

APRIL 2, 1987

MR. CHAIRMAN, FOR MANY YEARS, I HAVE BEEN PROMOTING AND ENCOURAGING THE DEVELOPMENT, DEMONSTRATION, AND COMMERCIAL UTILIZATION OF CLEAN COAL TECHNOLOGIES. THESE TECHNOLOGIES WILL ENSURE A FUTURE OF ABUNDANT, SECURE ENERGY SUPPLIES AT REASONABLE COST. I ALSO BELIEVE THAT THE LONG TERM DEVELOPMENT AND COMMERCIAL DEPLOYMENT OF THESE PROMISING TECHNOLOGIES WILL ASSURE US OF STEADY PROGRESS TOWARD RESOLVING THE ACID RAIN PROBLEM.

THE FEDERAL CLEAN COAL TECHNOLOGY PROGRAM, A PROGRAM WHICH I HAVE PROMOTED AND WHICH HAS ENJOYED STRONG BIPARTISAN SUPPORT IN BOTH CHAMBERS, HOLDS THE PROMISE OF ALLOWING US TO CONTINUE USE OF OUR MOST ABUNDANT FUEL SOURCE -- COAL -- IN AN ENVIRONMENTALLY SAFE, COST-EFFECTIVE MANNER. BUT, THE CURRENT DOE CLEAN COAL PROGRAM IS ONLY THE FIRST STEP TOWARD WIDESPREAD COMMERCIAL APPLICATION OF THESE TECHNOLOGIES.

LAST YEAR, I INTRODUCED, S.2188, THE ELECTRIC GENERATION AND INDUSTRIAL ENERGY DEVELOPMENT ACT, TO ENCOURAGE THE ADMINISTRATION TO FACILITATE THE MARKET ACCEPTANCE OF CLEAN COAL TECHNOLOGIES. THE BILL DIRECTED THE ADMINISTRATION TO IDENTIFY REGULATORY AND OTHER IMPEDIMENTS TO THE COMMERCIAL ADOPTION OF NEW AND ADVANCED COAL TECHNOLOGIES AND TO DEFINE COORDINATED POLICY MEASURES TO ADDRESS THEM.

EARLIER THIS YEAR, IN MY TESTIMONY BEFORE THE ENVIRONMENTAL PROTECTION SUBCOMMITTEE, I AGAIN CALLED FOR THE DEVELOPMENT OF A DEPLOYMENT STRATEGY THAT WOULD PROVIDE ADDITIONAL FINANCIAL AND REGULATORY INCENTIVES TO ASSURE THAT THE ELECTRIC UTILITY INDUSTRY AND OTHERS WILL COMMERCIALIZE THESE PROMISING TECHNOLOGIES. A FEDERAL CLEAN COAL TECHNOLOGY DEPLOYMENT PROGRAM IS THE NEXT LOGICAL STEP TOWARD FULL COMMERCIAL USE OF THE TECHNOLOGIES.

ON MONDAY (MARCH 30), I INTRODUCED S. 879, A BILL THAT WOULD TAKE US ANOTHER STEP CLOSER TO THE WIDESPREAD COMMERCIAL USE OF EMERGING CLEAN COAL TECHNOLOGIES. THE "CLEAN COAL TECHNOLOGY DEPLOYMENT ACT" WOULD PROVIDE FINANCIAL AND REGULATORY INCENTIVES TO THE ELECTRIC UTILITY INDUSTRY, AND OTHERS, TO CONSTRUCT INITIAL RISKY COMMERCIAL-SIZED CLEAN COAL TECHNOLOGY PROJECTS. THE DEPLOYMENT SUCCESS OF SUCH PROJECTS WILL FOSTER THE FINANCIAL AND REGULATORY CERTAINTY THAT IS A PREREQUISITE FOR FUTURE COMMERCIAL APPLICATIONS OF INNOVATIVE TECHNOLOGY.

MY BILL IS NEEDED BECAUSE, WHILE THE CURRENT CLEAN COAL PROGRAM IS DESIGNED TO PROVIDE INDUSTRY WITH TECHNICAL AND ECONOMIC INFORMATION FOR SMALLER, DEMONSTRATION SCALE PROJECTS, THERE IS STILL A SERIOUS NEED TO ADDRESS THOSE REGULATORY AND FINANCIAL RISKS ASSOCIATED WITH THE EARLY COMMERCIAL USE OF A NEW TECHNOLOGY. COMPANIES ARE ALWAYS RISK-AVERSE, BUT REGULATED FIRMS, SUCH AS ELECTRIC UTILITIES, ARE PARTICULARLY WARY OF TAKING TECHNOLOGICAL

RISKS. MY PROPOSAL, THROUGH FINANCIAL INCENTIVES AND THE REMOVAL OF SOME REGULATORY IMPEDIMENTS, WILL "BUY DOWN" THOSE RISKS AND WILL ENCOURAGE UTILITIES AND OTHERS TO DEPLOY CLEAN COAL TECHNOLOGIES THAT HAVE BEEN TESTED AT A LESS-THAN-COMMERCIAL SCALE.

MY CLEAN COAL TECHNOLOGY BILL PROVIDES $3.5 BILLION OVER TEN YEARS TO ASSURE THE COMMERCIALIZATION OF THESE EMERGING TECHNOLOGIES. I BELIEVE THIS IS A WISE INVESTMENT THAT WILL CLEARLY MORE THAN PAY FOR ITSELF IN THE LONG RUN. CONSIDER THE FOLLOWING:

1. RIGHT NOW, APPROXIMATELY 60 PERCENT OF OUR ELECTRIC ENERGY IS GENERATED FROM COAL. EXPERTS DISAGREE OVER THE AMOUNT OF NEW ELECTRICITY THE COUNTRY WILL REQUIRE IN THE FUTURE. BUT ACCORDING TO THE ELECTRIC POWER RESEARCH INSTITUTE'S (EPRI) MOST RECENT DATA, ELECTRICITY DEMAND WILL CONTINUE TO KEEP PACE WITH ECONOMIC GROWTH. IF SO, THEN A MODEST 2.5 PERCENT GROWTH RATE IN DEMAND MAY NOT BE UNREASONABLE. AT THIS RATE, PEAK ELECTRICITY DEMAND WILL EXCEED INSTALLED CAPACITY SOMETIME IN THE EARLY TO MID 1990'S.

AT A 2.5 PERCENT GROWTH RATE, THE U.S. WILL REQUIRE 100,000 TO 200,000 MEGAWATTS OF ADDITIONAL NEW CAPACITY THIS CENTURY. MUCH OF THIS NEW CAPACITY WILL BE COAL-FIRED. ENVIRONMENTAL CONCERNS OVER THE USE OF COAL TO PROVIDE THIS ADDITIONAL CAPACITY REQUIRE THAT WE DEVELOP WAYS TO BURN COAL MORE CLEANLY.

ACCORDING TO RECENT EPRI TESTIMONY: "NEW CLEAN COAL TECHNOLOGY NOW UNDER DEVELOPMENT COULD REDUCE THE COST OF THIS NECESSARY CAPACITY EXPANSION BY MORE THAN 50 PERCENT RELATIVE TO CURRENT EXPERIENCE." BOTH INDUSTRY AND GOVERNMENT ANALYSTS AGREE THAT A DEPLOYMENT PROGRAM WOULD RESULT IN THESE TECHNOLOGIES BEING AVAILABLE FIVE TO TEN YEARS EARLIER THAN WOULD OTHERWISE BE THE CASE. THUS, THE CURRENT CLEAN COAL PROGRAM, AND MY PROPOSED DEPLOYMENT PROGRAM, ARE ESSENTIAL TO MEETING OUR PROJECTED INCREASE IN ELECTRICITY DEMAND IN AN ENVIRONMENTALLY ACCEPTABLE, COST-EFFECTIVE MANNER.

2. SINCE 1980, CONGRESS HAS BEEN DEBATING WHAT SHOULD BE DONE ABOUT THE ACID RAIN "EMERGENCY." FOR A DECADE, WE HAVE BEEN WARNED THAT WITHOUT IMMEDIATE AND DRASTIC CONTROL MEASURES, OUR LAKES AND FORESTS WOULD BE FACED WITH IMPENDING DOOM. FORTUNATELY, IN 1980, CONGRESS PUT INTO PLACE A MASSIVE ACID RAIN RESEARCH PROGRAM. WHILE THE DEBATE HAS RAGED, SCIENTISTS HAVE BEEN CAREFULLY PERFORMING EXPERIMENTS AND GATHERING INFORMATION. THE RESULTS WILL NOT BE FULLY COMPLETED UNTIL THE END OF THE DECADE, BUT THE INFORMATION GATHERED THUS FAR INDICATES THAT THERE IS NO REASON TO BELIEVE THAT THE PROBLEM DEMANDS IMMEDIATE AND DRASTIC ACTION. THE IMPORTANT THING IS TO ACHIEVE STEADY

PROGRESS IN REDUCING EMISSIONS. IMMEDIATE, MASSIVE REDUCTIONS ARE NOT SCIENTIFICALLY DEFENSIBLE.

MR. CHAIRMAN, I AM DEEPLY CONCERNED ABOUT THE ENVIRONMENT. I BELIEVE THAT COAL SHOULD BE BURNED CLEANLY AND EFFICIENTLY. BUT I AM ALSO DEEPLY CONCERNED ABOUT JOB STABILITY AND THE WELFARE OF COMMUNITIES IN STATES SUCH AS MINE. I WORRY ABOUT THE COMPETITIVENESS OF OUR ENERGY-INTENSIVE INDUSTRIES, AND ABOUT THE ELECTRIC BILLS THAT RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL CONSUMERS MUST PAY. BECAUSE ACID RAIN IS NOT AN EMERGENCY, I BELIEVE THAT NONE OF THE ACID RAIN CONTROL BILLS INTRODUCED TO DATE HAS FOUND THE APPROPRIATE BALANCE BETWEEN ENVIRONMENTAL QUALITY AND ECONOMIC IMPACTS. THESE BILLS REQUIRE MAJOR SACRIFICE IN THE LIVELIHOODS OF MILLIONS OF OUR CITIZENS TO IMPROVE ENVIRONMENTAL QUALITY FOR OTHERS.

PERHAPS I WOULD NOT DEMAND AS MUCH SCIENTIFIC CERTAINTY ON THE IMPACTS OF ACID RAIN IF THE IMPACTS OF PROPOSED REGULATORY BILLS WERE NOT SO SEVERE. BUT SEVERE THEY ARE, INDEED. THESE BILLS WOULD NOT ONLY BE EXPENSIVE, SOCIALLY DISRUPTIVE AND INJURIOUS TO OUR COMPETITIVE POSITION, BUT THEY COULD ALSO HARM THE ENVIRONMENT IN THE LONG RUN. THE TIME AND MONEY THAT COULD BE SPENT DEVELOPING AND DEPLOYING NEWER, CLEANER COAL TECHNOLOGIES WOULD INSTEAD BE DIVERTED TO COSTLY AND INEFFICIENT RETROFITTING EQUIPMENT OR SWITCHING COALS IN ORDER TO MEET THE REQUIREMENTS THESE BILLS WOULD IMPOSE.

MANY OF THE CLEAN COAL TECHNOLOGIES NOW UNDER DEVELOPMENT CAN DO BETTER THAN THE CURRENT NEW SOURCE PERFORMANCE STANDARDS (NSPS) FOR BOTH SO2 AND NOX. CURRENTLY, PROPOSED ACID RAIN LEGISLATION WILL ACHIEVE NEAR TERM REDUCTIONS -- BUT IT WILL DO SO ONLY AT THE EXPENSE OF THE LONG TERM. CONTINUING WITH THE CURRENT CLEAN COAL PROGRAM, AND ESTABLISHING A DEPLOYMENT PROGRAM TO ASSURE THE COMMERCIAL ADOPTION OF EMERGING CLEAN COAL TECHNOLOGIES MAKES BETTER SENSE IN THE LONG TERM -- BETTER ECONOMIC SENSE, BETTER ENVIRONMENTAL SENSE, AND BETTER ENERGY POLICY SENSE -- THAN ADOPTING AN ACID RAIN BILL WITH ONLY NEAR-TERM ENVIRONMENTAL BENEFITS.

3. WHILE THERE IS STRONG DISAGREEMENT OVER THE NEED FOR PROPOSED ACID RAIN LEGISLATION, THERE IS A GROWING CONSENSUS THAT CLEAN COAL TECHNOLOGIES AFFORD US STEADY PROGRESS TOWARD REDUCING EMISSIONS. THE FEDERAL GOVERNMENT SHOULD CONTINUE ITS COMMITMENT TO THE DEVELOPMENT OF THESE PROMISING TECHNOLOGIES AND SHOULD ADOPT A DEPLOYMENT PROGRAM THAT WILL ASSURE THEIR COMMERCIAL USE AS QUICKLY AS POSSIBLE.

4. WITH THE ENACTMENT OF THE CLEAN COAL TECHNOLOGY PROGRAM, THE CONGRESS TOOK A BOLD STEP IN ENSURING THE TIMELY DEVELOPMENT OF A RANGE OF TECHNOLOGICAL OPTIONS FOR

THE CLEAN USE OF COAL. THE AVAILABILITY OF SUCH OPTIONS IS IMPORTANT FOR THE PLANNING AND CONSTRUCTION OF POWERPLANTS TO PROVIDE NEW ELECTRIC GENERATING CAPACITY TO MEET THE NATION'S FUTURE ENERGY NEEDS. OF EQUAL IMPORTANCE, ELECTRIC UTILITIES CONSIDERING WHETHER TO MAKE CAPITAL INVESTMENTS TO EXTEND THE LIFE OF EXISTING GENERATING FACILITIES, WILL HAVE A VARIETY OF TECHNOLOGIES FROM WHICH TO CHOOSE. FINALLY, FOR ENERGY INTENSIVE INDUSTRIES, SUCH AS STEEL AND ALUMINUM, IMPROVEMENTS IN THE PRODUCTION OF ENERGY THROUGH THE USE OF CLEAN COAL TECHNOLOGIES CAN CONTRIBUTE TO THE ENHANCEMENT OF THE COMPETITIVENESS OF SUCH INDUSTRIES IN INTERNATIONAL MARKETS.

5. AS OUR UNDERSTANDING OF ACID RAIN SCIENCE EVOLVES, WE MAY DECIDE THAT A RETROFIT PROGRAM IS WARRANTED. IF THAT WERE TO HAPPEN, THE AVAILABILITY OF INNOVATIVE TECHNOLOGIES COULD REDUCE COMPLIANCE COSTS BY AS MUCH AS 50 PERCENT WHEN COMPARED TO EXISTING SCRUBBER TECHNOLOGY. A 50 PERCENT REDUCTION IN COMPLIANCE COSTS WOULD MAKE AN ENORMOUS DIFFERENCE IN HARD HIT STATES SUCH AS WEST VIRGINIA.

I ASK THE SENATE TO TAKE THE NEXT BOLD STEP TO ASSURE THAT, ONCE DEVELOPED, THESE TECHNOLOGICAL OPTIONS FOR CLEAN USE OF COAL ARE COMMERCIALLY DEPLOYED BY THE PRIVATE SECTOR. UNFORTUNATELY, THE FEDERAL GOVERNMENT CANNOT RISK "BOWING OUT" DURING ANY STEP IN THE PROCESS OF DEVELOPING THESE IMPORTANT TECHNOLOGIES. THE COSTS TO OUR ENVIRONMENT, OUR ECONOMY AND OUR INDUSTRIAL COMPETITIVENESS ARE JUST TOO GREAT SHOULD WE ALLOW THESE TECHNOLOGIES TO BE SHELVED. I TAKE GREAT PLEASURE IN BEING ABLE TO REPORT TO YOU TODAY THAT THE ADMINISTRATION, WHICH AT ONE TIME STAUNCHLY OPPOSED MY CLEAN COAL PROGRAM, IS NOW ONE OF THE PROGRAM'S STRONGEST ADVOCATES.

IN ITS BUDGET REQUEST FOR FY 1988, THE ADMINISTRATION REQUESTED A SIGNIFICANT INCREASE IN FUNDING FOR THE PROGRAM OVER THE NEXT SEVERAL YEARS. TWO WEEKS AGO, THE ADMINISTRATION COMMITTED TO FULLY FUNDING THE RECOMMENDATIONS OF THE JOINT REPORT OF THE U.S.-CANADIAN SPECIAL ENVOYS. THE PRESIDENT VOWED TO SEEK $2.5 BILLION FOR THE DEMONSTRATION AND DEPLOYMENT OF CLEAN COAL TECHNOLOGIES.

I SUPPORT THE ADMINISTRATION'S EFFORTS TO FULFILL OUR COMMITMENT TO CANADA. ALTHOUGH THERE ARE SOME IMPORTANT DISTINCTIONS BETWEEN MY BILL AND THE JOINT ENVOYS' PROGRAM, I BELIEVE THAT THERE IS ENOUGH OVERLAP AND COMPATIBILITY THAT WE CAN WORK WITH THE ADMINISTRATION TO ACHIEVE BOTH SETS OF GOALS.

I HAVE ATTACHED A SIDE-BY-SIDE COMPARISON OF MY BILL, THE ADMINISTRATION'S PROPOSAL, AND THE DREW LEWIS RECOMMENDATIONS. MY PROGRAM IS LONGER TERM AND MORE BROADLY CONCEIVED THAN THAT OF THE JOINT ENVOYS. THE JOINT ENVOYS'

PROGRAM IS LIMITED TO RETROFIT TECHNOLOGIES ON SOURCES THAT AFFECT CANADA. MY PROGRAM WOULD FUND BOTH RETROFIT TECHNOLOGIES THAT COULD ACHIEVE NEAR TERM EMISSION REDUCTIONS AS WELL AS NEW ADVANCED TECHNOLOGIES THAT WILL POWER AMERICA'S NEXT GENERATION OF PLANTS. MY PROGRAM WOULD SPEND $3.5 BILLION OVER TEN YEARS, OR $350 MILLION PER YEAR. THE PRESIDENT'S PROGRAM WOULD SPEND $2.5 BILLION OVER FIVE YEARS, OR $500 MILLION PER YEAR. I BELIEVE THAT A LOWER RATE OF SPENDING OVER A LONGER TIME PERIOD IS PREFERABLE FOR TWO REASONS: (1) ITS LOWER IMMEDIATE BUDGETARY IMPACT; AND, (2) THE LESSONS LEARNED FROM THE EARLY PROJECTS CAN BE APPLIED TO THE LATER PROJECTS. THE ADMINISTRATION'S PROGRAM WOULD BE LIMITED TO TECHNOLOGIES THAT COULD BE SELECTED TODAY; MY PROGRAM WOULD INCLUDE TECHNOLOGIES THAT COULD BE SELECTED TOMORROW.

THIS IS ONE ISSUE WHERE I TAKE GREAT PRIDE IN NOW BEING ON THE SAME SIDE AS THE ADMINISTRATION. WITH THE PRESIDENT'S SHARED COMMITMENT TO THE DEVELOPMENT AND DEPLOYMENT OF CLEAN COAL TECHNOLOGIES, I FEEL CERTAIN THAT, TOGETHER, THE ADMINISTRATION AND CONGRESS CAN CRAFT A PRODUCTIVE NATIONAL CLEAN COAL PROGRAM. TOGETHER, WE CAN SAFELY EXPAND THE USE OF COAL TO POWER OUR NATION'S ECONOMIC GROWTH. TOGETHER, WE CAN ENSURE THAT WE WILL HAVE LONG TERM DOMESTIC SUPPLIES OF CLEAN ENERGY. TOGETHER, WE CAN MOVE TO THE FOREFRONT OF THE DEVELOPMENT OF CLEAN COAL TECHNOLOGIES FOR DOMESTIC AS WELL AS INTERNATIONAL MARKETS. AND TOGETHER, WE CAN DEVELOP A PROGRAM THAT WILL IMPROVE THE ENVIRONMENT WHILE MAKING AMERICA MORE COMPETITIVE -- BOTH TECHNOLOGICALLY AND INDUSTRIALLY. THESE ARE NOBLE NATIONAL GOALS THAT CAN ONLY BE ACHIEVED WITH CONTINUED BIPARTISAN SUPPORT IN CONGRESS AND THE CONTINUED SUPPORT OF THE PRESIDENT.

THE ADMINISTRATION HAS RECOGNIZED THE NEED FOR FURTHER FEDERAL INVOLVEMENT IN THE DEVELOPMENT OF CLEAN COAL TECHNOLOGIES. THE EVER-INCREASING IMPORTANCE OF RAPIDLY INCORPORATING THESE TECHNOLOGIES INTO THE COMMERCIAL MARKETPLACE HAS BEEN UNDERSCORED. ENACTMENT OF S. 879 WILL ASSURE THAT THESE PROMISING NEW TECHNOLOGIES ARE COMMERCIALLY AVAILABLE AS QUICKLY AS POSSIBLE TO ALLOW US TO CONTINUE TO USE OUR MOST ABUNDANT FUEL SOURCE -- COAL -- IN A CLEAN, COST-EFFECTIVE MANNER.

## COMPARISON OF BYRD BILL WITH CLEAN COAL PROGRAMS PROPOSED BY THE ADMINISTRATION AND SPECIAL ENVOYS

| BYRD: CLEAN COAL DEPLOYMENT | ADMINISTRATION PROGRAM | ENVOYS' REPORT |
|---|---|---|
| PURPOSE | | |
| 1. Provide federal financial assistance for initial, "risky" commercial scale Clean Coal Technologies on new and existing facilities which will maximize pollution abatement over the long term while improving power efficiency and reliability. | 1. Essentially same as Byrd bill but has emphasis on retrofits and near-term activities. | 1. Emphasis on near-term pollution abatement through demonstration of new technologies aimed at reducing U.S. emissions that affect Canada. |
| 2. Reduce certain federal regulatory impediments to the deployment of Clean Coal Technologies. | 2. Six-month study of regulatory impediments. | 2. No provision. |
| 3. Encourage supportive state policies. | 3. Same as above. | 3. No provision. |
| 4. Reduce all types of pollution from coal-burning facilities in all locations. | 4. Emphasis on, but not limited to, reduction of transboundary $SO_2$ and $NO_x$ pollution. | 4. Reduce transboundary air pollution and expand menu of control technology options. |
| MAIN PROVISIONS | | |
| *Financial Assistance* | | |
| 1. Authorizes the appropriation of $350,000,000 per year for 10 years commencing upon enactment. Unappropriated balances remain available until appropriated. | 1. Request of $500,000,000 per year for 5 years. | 1. Same as Administration. |
| 2. Total authorization of $3,500,000,000 is in addition to $750,000,000 previously appropriated to the Clean Coal Technology Reserve. | 2. Total request of $2,500,000,000 includes $150,000,000 in "old money" previously appropriated for Clean Coal I, and uses $350,000,000 of the remaining authorization in the Clean Coal Technology Reserve. | 2. Total proposal of $2,500,000,000 in all "new money." |
| 3. Eligible facilities: Both new and existing facilities; and both utility and industrial plants which use coal. | 3. Funds would be available for all coal applications but limited to retrofitable and repowering technologies. | 3. Same as Administration but emphasizes technologies and sites which can most greatly reduce transboundary air pollution. |
| 4. Selection criteria: (*a*) Projected commercial efficiency and effectiveness of the proposed technology in producing energy and reducing pollution on a systemwide, life-cycle basis; (*b*) Market penetration potential of the technology at existing sites, especially those that contribute to transboundary pollution; (*c*) Applicability of the technology to existing high-sulfur coal burners. | 4. Essentially the same as Byrd bill. | 4. Narrower—does not require energy efficiency. Emphasizes efficient pollution reduction at sites using high-sulfur coal, and that contribute to transboundary air pollution only. |
| 5. Types of assistance: (*a*) Project construction and operation grants; (*b*) certain regulatory treatments outlined in the next section. | 5. Broad range of potential financial assistance including grants and cooperative agreements. | 5. Unspecified. |

### COMPARISON OF BYRD BILL WITH CLEAN COAL PROGRAMS PROPOSED BY THE ADMINISTRATION AND SPECIAL ENVOYS—Continued

| BYRD, CLEAN COAL DEPLOYMENT | ADMINISTRATION PROGRAM | ENVOYS' REPORT |
|---|---|---|
| 6. Limits on financial assistance to projects: (*a*) Federal government may not provide any more than 50 percent cost-sharing during any phase of the project; (*b*) Federal government may not cost-share overruns in excess of 25 percent of the original project cost. | 6. Same as Byrd bill except that recoupment of Government's investment in each project is required. | 6. Same as Byrd bill except silent on cost sharing of overruns. |
| FEDERAL REGULATORY ACTIONS | | |
| 1. FERC shall apply the following criteria when determining the "just and reasonable" rate for any clean coal project under its jurisdiction:<br>*a*. Project design and engineering costs shall be allowed as an operating expense.<br>*b*. Related capital costs are to be included in the rate/base as incurred.<br>*c*. Capital costs not treated as operating expenses may be amortized over 5 years.<br>*d*. An incentive rate of return shall be provided for any capital costs included in the rate base.<br>*e*. Clean coal projects are presumed to be a prudent expense unless proven otherwise. | Proposes no statutory regulatory provisions. Vice President will review and provide recommendations within 6 months potential administrative changes to facilitate the commercial use of clean coal technologies. | No provision. |
| 2. The FERC may grant exemptions to the Public Utility Holding Act and parts II and III of the Federal Power Act. | | |
| STATE PROGRAM | | |
| 1. Secretary of Energy shall consider the extent to which a State has adopted the appropriate regulatory actions noted above before selecting a clean coal project in that State. | No provision. | No provision. |
| 2. In State regulatory proceedings, clean coal projects are presumed to be a prudent expense unless proven otherwise. | | |
| IMPLEMENTATION | | |
| 1. Financial assistance to be available as appropriated. Appropriations may be made indefinitely into the future as long as the authorized total of $3,500,000,000 has not been reached. | 1. Fiscal years 1988 through 1992. | 1. For 5 years beginning as soon as possible. |
| 2. Regulatory authorities are to begin within 6 months of enactment. | 2. No provision. | 2. No provision. |

### COMPARISON OF BYRD BILL WITH CLEAN COAL PROGRAMS PROPOSED BY THE ADMINISTRATION AND SPECIAL ENVOYS—Continued

| BYRD: CLEAN COAL DEPLOYMENT | ADMINISTRATION PROGRAM | ENVOYS' REPORT |
|---|---|---|
| ADVISORY | | |
| 1. No provisions. | 1. Establish innovative control technology panel to provide advice and recommendations concerning cost-effective control technologies. Representation from Federal agencies, State government, Canadian government and special interest groups. | 1. Establish innovative control technology panel to oversee and select projects to be co-funded. Membership same as administration program. |

Senator Ford. I thank the Senator for his testimony this morning. I, for one, look forward to working with him and others to see his desire fulfilled, and many others that have the same feeling, to carry out this ambitious program.

It always frustrates me just a little bit, about the time it seems like we are on the right track and moving, something comes along to jolt it a little bit.

But perseverance, I think, will win out. I admire you for that and look forward to working with you.

I have no questions for the Majority Leader.

Senator Hecht, do you have any questions?

Senator Hecht. No. Thank you, Mr. Chairman; no questions.

Senator Ford. Fine. We thank you, Senator, and look forward to working with you.

Senator Byrd. Thank you, Mr. Chairman. I congratulate you on conducting the hearings; and I also commend you and thank you for the support that you have consistently given to clean coal technology. You're doing a great service to your state and a great service to the country.

I'm sorry that you're going to be pressured this morning by time. But continue in your good work.

Thank you.

Senator Ford. Thank you very much, Senator.

The next speaker who is scheduled to testify is George Evans, Secretary, Kentucky Energy Cabinet. George Evans has dedicated his life in the interest of coal, and now with the new uses, and he has done an admirable job with new technologies and so forth.

I'm very pleased that Secretary Evans could be with us this morning to testify. We look forward to your testimony, George. However you wish to do it, you can submit it all for the record and highlight it, however, you wish to do it.

## STATEMENT OF GEORGE E. EVANS, JR., SECRETARY, KENTUCKY ENERGY CABINET

Mr. Evans. Mr. Chairman and Members of the Subcommittee, you have a copy of my prepared statement, and I request that it be included in the record.

Senator Ford. It will be included in its entirety.

Mr. Evans. I am here today because I am concerned that this nation might be on a collision course with another oil shock. Note that I say "might be."

I strongly believe we can avoid the collision, if we adopt the correct policies. For that reason, I commend this Subcommittee for its efforts with regard to clean coal technology.

Along the same lines, two weeks from today, Governor Martha Layne Collins and I will be hosting Coal Summit II in Lexington. By bringing together top leaders from government and industry, we want the Summit to set forth a series of recommendations that will encourage a wiser and more rational use of America's energy resources.

Why is this necessary? Because for far too long energy has not been viewed as an important national issue. It is time once more to factor energy into America's policy equation.

Awash with foreign oil, we have forgotten the two oil shocks of the seventies. We have forgotten conservation and alternate energy development. As a result, petroleum demand is increasing steadily; domestic production is falling dramatically; and imports are rising at an alarming rate.

We are just short years—and perhaps only months—away from importing more oil than we produce. Our vulnerability to another energy crisis increases daily.

The fundamental question confronting us today then is this: How do we reduce our reliance on foreign oil?

I see four ways: Increased conservation, increased use of natural gas, increased use of coal, increased use of alternate fuels from coal and oil shale.

At one time we believed that nuclear energy and its inexpensive electricity would help move us away from increased reliance upon foreign oil. However, lengthened construction timetables, escalating plant costs and heightened public concerns over safety have all but eliminated the nuclear option.

Natural gas is abundant, affordable and available from secure sources. Increasingly we should be moving to displace foreign oil with domestic gas in as many applications as possible.

This is particularly true in the transportation sector where already our demand for petroleum exceeds domestic production.

However, in considering repeal of the Fuel Use Act, we should take care to insure that it is imported oil and not coal that we are replacing with natural gas.

We should instead be increasing our reliance on coal. Oil and gas, while comprising less than eight percent of our hydrocarbon reserves, account for nearly 70 percent of our energy consumption.

Coal, on the other hand, comprises more than 80 percent of our reserves, yet accounts for less than 30 percent of our consumption. This destructive pattern must change if we are ever to have national energy security.

I am very much aware of the international debate and controversy over acid rain and the implications for increased coal utilization. Those who know me will tell you that I have spent my adult life producing coal and that I am a staunch coal advocate. That is true.

However, those who know me well will also tell you that I have been a fisherman even longer. I am also concerned about the quality of our lakes, and that is no fisherman's tale.

Increased coal utilization is not a choice between energy security and environmental quality. We can have both. To me it is clear that we must have both.

We can achieve this through vigorous programs of fossil energy research and the development of clean coal technology.

The Congress is to be commended for its $750 million commitment to clean coal technology and for continuing to restore slashed fossil energy research budgets.

Earlier research has taken us to the point where several emerging technologies show extraordinary promise in being able to reduce emissions well below those achievable with scrubbers.

My recommendation to you today is for an expanded, but focused, clean coal technology program to accelerate the deployment of these technologies. The sooner we can proceed with the deployment of advanced technology and the development of even better technology to replace that, the sooner we will have both clean air and energy security.

I have attached to my statement the briefing document for Coal Summit II, which gives additional information in support of my testimony.

I want to thank you for this opportunity to present my views to you today. I will be happy to answer any questions that you may have.

[The prepared statement of Mr. Evans follows:]

# STATEMENT BY GEORGE E. EVANS, JR.
SECRETARY, KENTUCKY ENERGY CABINET
SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
APRIL 2, 1987

Mister Chairman and Members of the Subcommittee

My name is George E. Evans, Jr. and I am Secretary of the Kentucky Energy Cabinet. I am here today because I am concerned that this nation might be on a collision course with another oil shock.

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I have attached to my Statement the briefing document for Coal Summit II which gives additional information in support of my testimony.

Thank you for this opportunity to present my views to you today. I will be happy to answer any questions that you may have.

# Factoring Energy Into America's Policy Equation

prepared for
Coal Summit II
April 15-17, 1987
Lexington, Kentucky

Kentucky Energy Cabinet
George E. Evans, Jr.,
Secretary

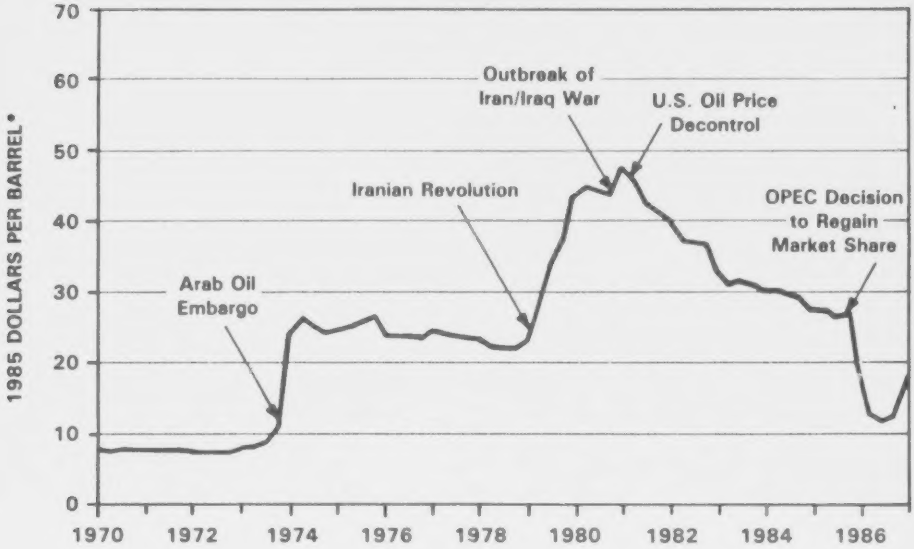
# PREFACE

"Factoring Energy Into America's Policy Equation" offers the U.S. energy picture graphically and in a brief narrative. Accompanying this picture is a series of discussion issues and information about topics of current concern. The idea is to provide the participants at Coal Summit II with a common pool of background information along with an outline of the possible policy choices.

We do not set forth recommendations. Instead, we seek to outline and clarify what choices actually confront America as well as their costs and probable benefits. These choices should be viewed in the context of a growing consensus that the trend toward rapidly rising oil imports is not in the national interest.

This information is drawn from readily-obtainable sources published or otherwise provided by, among others, the U.S. Department of Energy, the American Petroleum Institute and the National Academy of Sciences. Data and other information are, of course, available in far more detail. We have chosen that which goes to the heart of today's energy problems. Combined with the messages of our speakers, this should provide a point of departure for the informed discussions that will produce specific policy recommendations to place America on a sounder energy foundation.

## OIL PRICES REFLECT INTERNATIONAL EVENTS

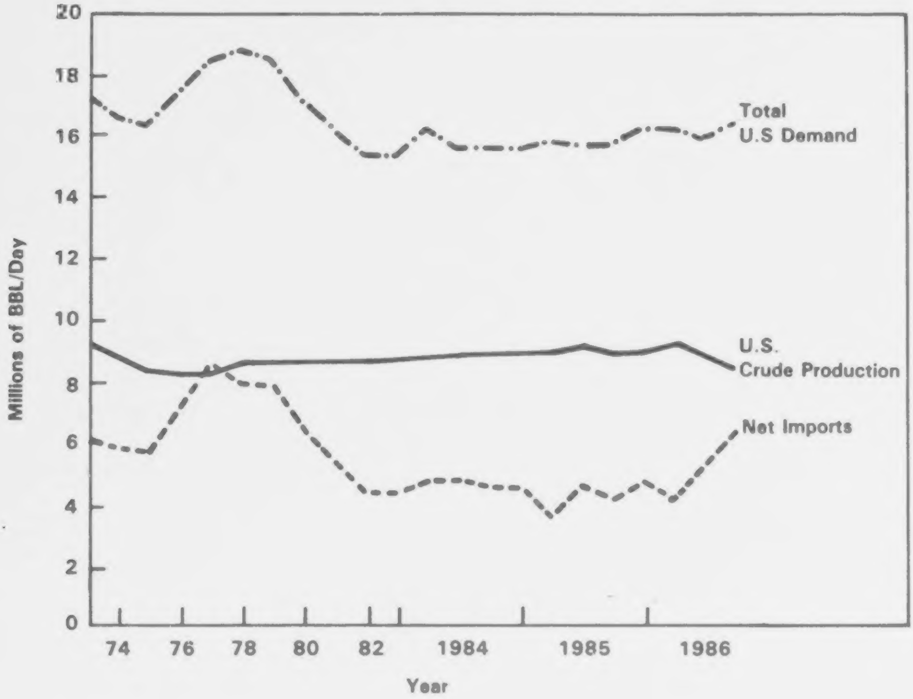


*Average quarterly cost of crude oil imported by U.S. refiners.

*Source: U.S. Energy Information Administration*

For nearly two decades energy production and consumption patterns in the United States have been whip-sawed by the flow of international events.

## HISTORICAL U.S. PETROLEUM PRODUCTION AND DEMAND



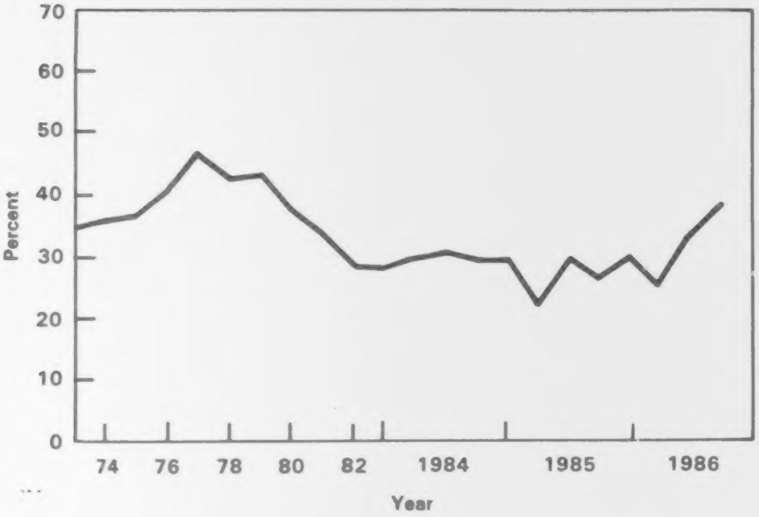
*Source: Energy Information Administration*

- Total U.S. petroleum demand reached its peak shortly before the oil shock of 1979, fell, held steady and has now begun to rise again.

- U.S. crude production rose only slightly for the decade from 1976 to early 1986, holding almost steady, then dropped precipitously in 1986, falling by more than 400,000 barrels per day.

- Net imports of petroleum fell dramatically after the 1979 oil shock, levelled off, then rose rapidly during the last three quarters of 1986, threatening to wipe out nearly a decade of progress in reducing imports.

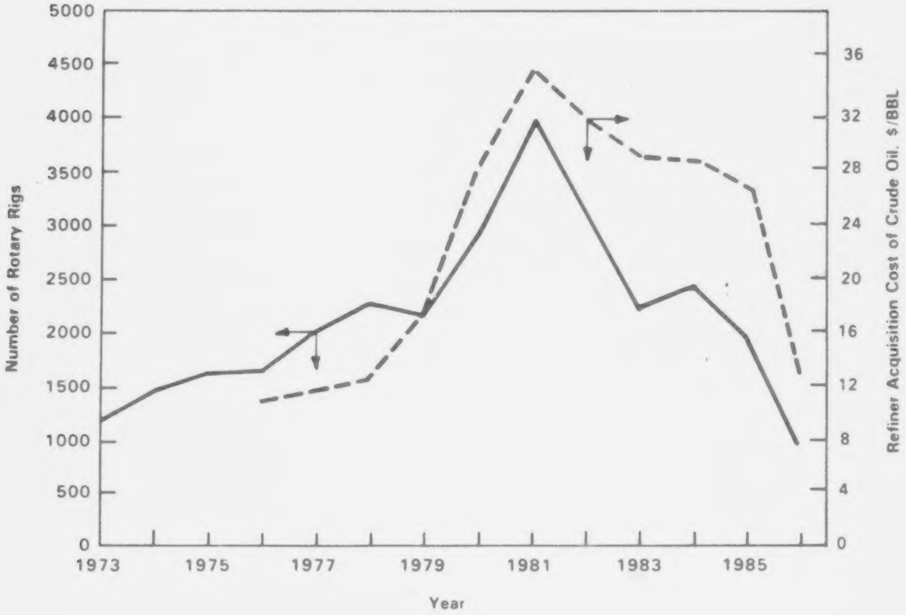
## HISTORICAL PERCENTAGE OF U.S. PETROLEUM CONSUMPTION SUPPLIED BY IMPORTS



*Source: Energy Information Administration, Monthly Energy Review, October, 1986.*

— The percentage of America's petroleum supplied by imports fell steadily from 1977 to 1985. Rapid increases in 1986, however—increases which are continuing today—are projected to wipe out those gains.

## ROTARY RIGS IN OPERATION, 1973-1986



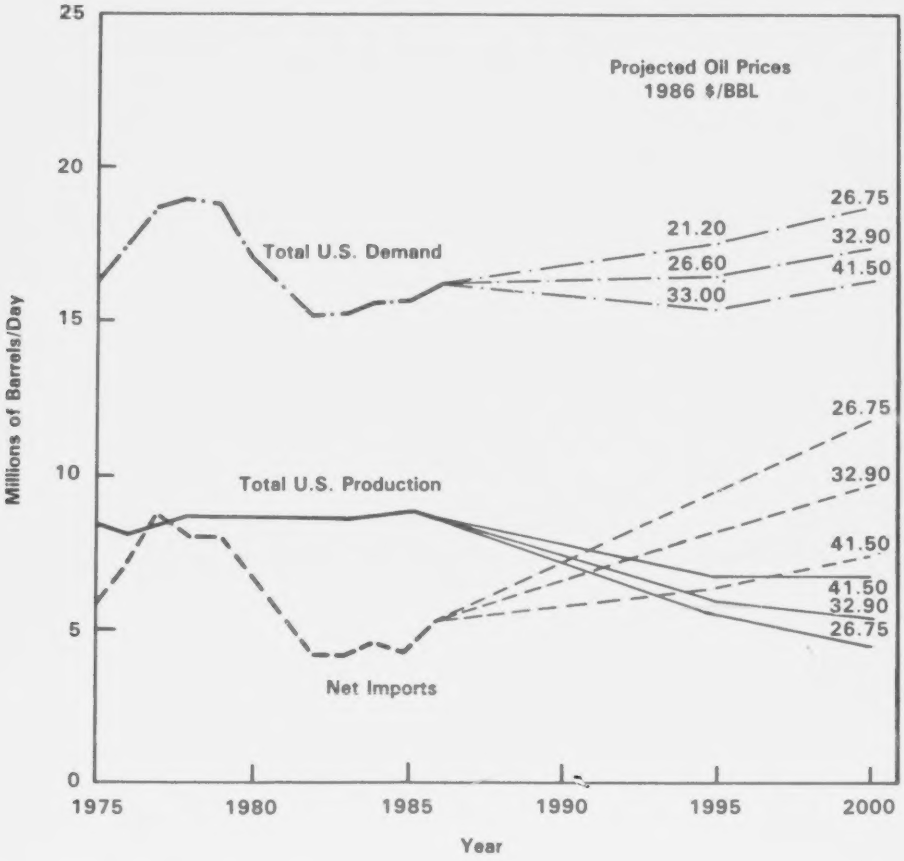
*Source: U.S. Energy Information Administration Monthly Energy Review, October 1986.*

Oil and gas exploration activities, as inferred from the number of rotary rigs in operation, are acutely sensitive to oil prices.

Rising oil prices in the late 1970's led to nearly 4,000 rigs in operation.

Declining oil prices in the early 1980's have led to fewer than 1,000 rigs in operation today.

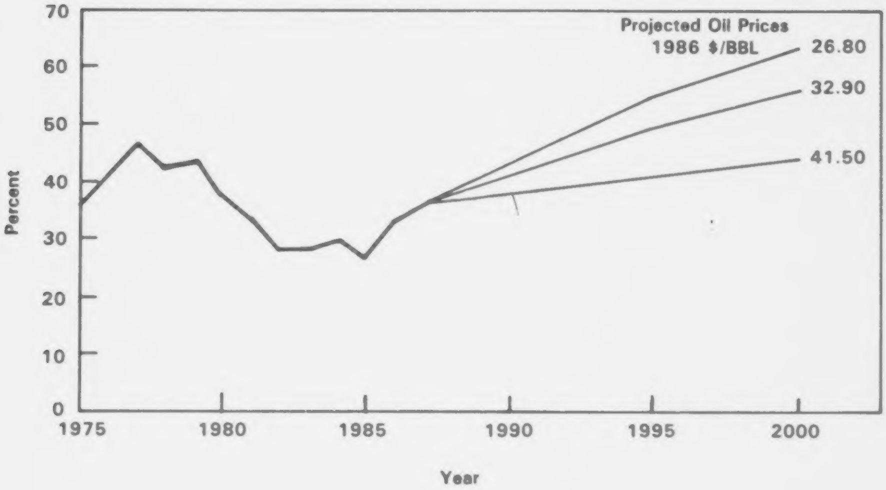
## PROJECTED U.S. PETROLEUM PRODUCTION AND DEMAND



*Source: Energy Information Administration.*

- The lower the price of oil, the faster U.S. demand increases.
- The lower the price of oil, the faster U.S. crude petroleum production decreases.
- The lower the price of oil, the greater the level of imports. Depending on the price, today's projections show that the U.S. would be importing more than it produces as early as 1991 or as late as 1999.

## PROJECTED PERCENTAGE OF U.S. PETROLEUM CONSUMPTION SUPPLIED BY IMPORTS



*Source: U.S. Department of Energy, Natural Energy Policy Plan Projections to 2010; December, 1985.*

— Projections based on today's price trends indicate that the U.S. could be importing as much as 60% of the total oil it uses as early as 1995.

# *SUMMARY*

A growing number of Americans believe that this trend toward rapidly rising oil imports is not in the national interest and are suggesting possible actions to slow or reverse it. In particular, the nation is being urged to:

- Build up the strategic petroleum reserve more quickly.
- Increase conservation.
- Increase domestic oil production, and
- Speed development of alternate energy sources.

These proposals, outlined in more detail in the following pages, are suggested as topics on which participants at Coal Summit II might voice their views and sentiments. No particular point of view is encouraged or discouraged, and participants should feel free to add any additional topics or thoughts they might have.

# DISCUSSION ISSUES

## Build Up the Strategic Petroleum Reserve

The strategic petroleum reserve presently holds about 515 million barrels of oil, an amount exceeding that withheld from world oil markets during the 1973 embargo. At its targeted level of 750 million barrels, the SPR could provide about one-half of U.S. imports for nine months.

Proponents argue for filling the SPR at a rate of at least 75,000 barrels per day as opposed to a proposed 35,000 barrels per day and for expanding the pipeline system to distribute the oil. The SPR's existence is felt to discourage the use of oil as a political or economic weapon against the United States.

## Increased Conservation

In the past decade, increased conservation has been very effective in reducing the nation's dependence on imported oil. Many of the easy gains have already been achieved, however, and other efforts are not likely to lessen America's dependency to the extent earlier ones did. The impressive gains in gasoline mileage, for example, will be extremely difficult to match.

Moreover, in light of what appears to be an oil glut, the Congress is proposing raising the 55 mph speed limit and relaxing fleet fuel economy standards, moves questioned by many concerned by the nation's trends in energy.

The transportation sector presently consumes more petroleum than total U.S. production and suitable replacements for gasoline, diesel and jet fuel are not yet available. To discourage consumption in this area, increased gasoline taxes have been proposed. Proponents claim benefits would possibly include reduced oil imports, a lower world price, small reductions in consumption base and peak price in the event of a disruption and increased federal tax receipts; opponents claim the disadvantages would include a slowed economy, increased unemployment, higher inflation, and reduced revenues for transportation and other affected areas of the economy.

## Increased Domestic Oil Production

An oil import fee has been suggested as a means of increasing domestic exploration and production while also curtailing imports. Proponents estimate that a $5 per barrel fee would reduce imports by 600,000 barrels per day, add $3.7 billion to treasury receipts over five years and preserve the domestic industry. Possible disadvantages include a 1% boost in annual inflation, a 0.7% drop in GNP growth rate and reduced U.S. industrial competitiveness in world markets. Some fear such a fee would never pass Congress without a great number of exemptions being added and that administering these would require the creation of a counterproductive bureaucracy.

Repealing the windfall profits tax and restoring the depletion allowance are frequently mentioned as alternatives to an import fee. The windfall profits tax could ultimately take 70% of the revenues that producers earned in excess of $18.50 per barrel. Proponents of repeal argue that at current prices repeal would not result in any loss of revenue to the federal government. Any costs of restoring the depletion allowance to big, integrated producers would be recovered by additional taxes on the increased production the allowance would stimulate, supporters of this measure claim. At the heart of the issue, however, is the question of assurances that increased profits would be reinvested in energy production rather than in unrelated ventures.

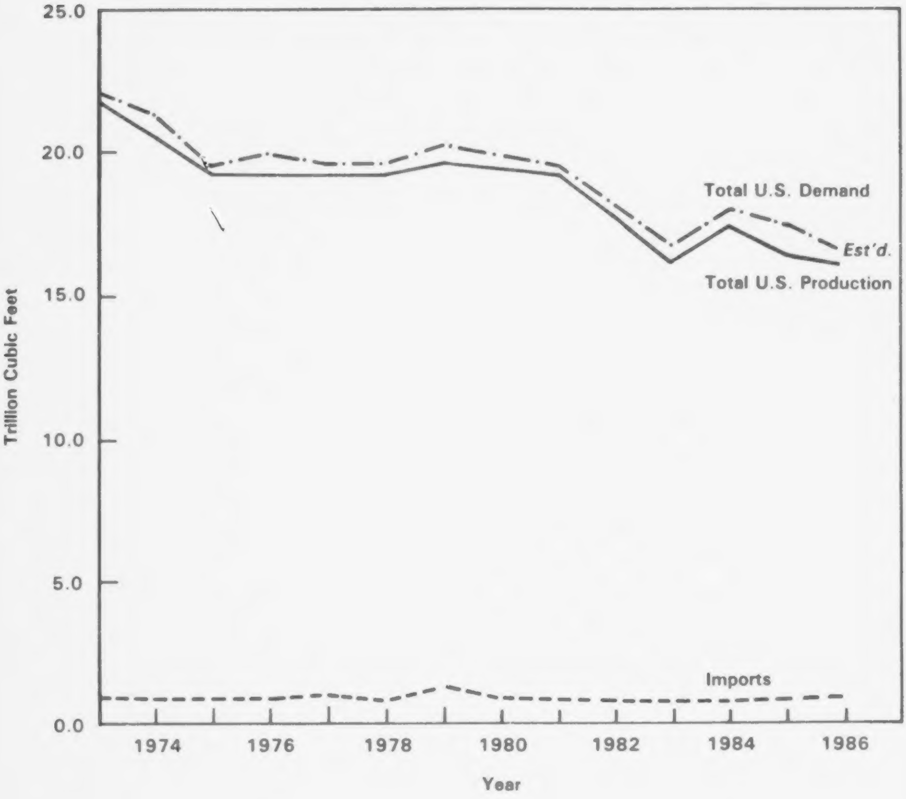
The American Petroleum Institute estimates that production from offshore California and in the Artic might replace as much as one million barrels per day of imported oil. As much as 3.2 billion barrels could be produced off California, according to these estimates. The Arctic National Wildlife Refuge, another promising area for exploration and production, is geologically next door to the 9.6 billion barrels of reserves at Prudhoe Bay. Accelerated oil and gas exploration with utmost protection to the environment will be at the center of this debate.

### Increased Reliance on Alternate Energy Sources

Nuclear energy, natural gas and coal can replace significant amounts of imported oil. Nuclear energy worldwide accounts for the fossil energy equivalent of 7 million barrels of oil daily. While the U.S. has the world's largest nuclear power program, a host of uncertainties cloud the future. Since the early 1970s, the time required to build a nuclear power plant has more than doubled and construction costs have increased tenfold. More than 100 nuclear power plant orders have been cancelled since 1974 and no post-1973 orders still stand. Incidents at Three Mile Island and Chernobyl have heightened public fears concerning safety and have further slowed the deployment of nuclear technology. Nuclear power's long-term economic competitiveness has diminished and its future role is difficult to assess. An appropriate question is nuclear power's optimum role in America's future as compared with its likely role. How great is the distance between the two? Can that distance be reduced?

In the interim, it is natural gas and coal that will increasingly have to substitute for petroleum in the U.S. economy.

# HISTORICAL NATURAL GAS PRODUCTION AND DEMAND

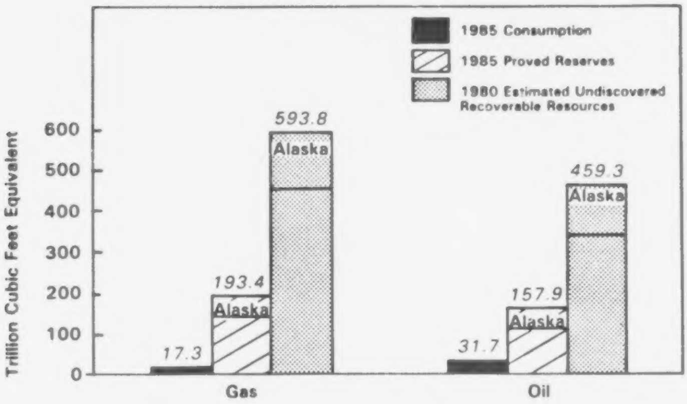


*Source: Energy Information Administration.*

Unlike oil, U.S. production and consumption of natural gas are in balance.

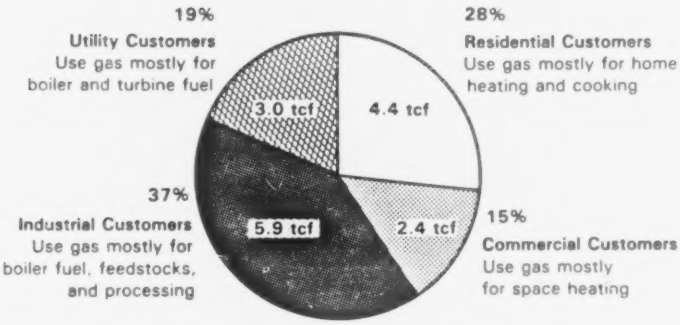
The magnitude of importation is small and from secure sources.

## U.S. NATURAL GAS RESOURCES ARE COMPARABLE TO OIL RESOURCES



*Source: Energy Information Administration*

## NATURAL GAS CONSUMPTION BY END-USE SECTOR, 1985



Domestic natural gas reserves exceed those of petroleum and consumption rates are considerably less.

Although gas could quickly replace oil in many industrial and utility applications, the Powerplant and Industrial Fuel Use Act (PIFUA) restricts the use of gas by large volume industrial and utility users.

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# THE POWERPLANT AND INDUSTRIAL FUEL USE ACT

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**Purpose of PIFUA**

- Force existing utilities and large industrial boilers off natural gas
- Discourage construction of new gas-fired units

**PIFUA Requirements**

- Coal Capability
  - New utility and large industrial boilers must be constructed capable of burning alternate fuels—coal, gas, or oil
- Demand Restraints
  - New boilers may not burn oil or natural gas
- Exemptions
  - USDOE administers an exemption process which provides relief for special situations including peaking units, cogeneration, environmental and site constraints and fuel availability.

## HISTORY OF PIFUA

The failure of regulated wellhead prices to keep pace with rising production costs led to shortages and curtailments of natural gas in the winter of 1976-77. In response to this, Congress passed the Powerplant and Industrial Fuel Use Act and the Natural Gas Policy Act. The purpose of PIFUA was to take large volume users off natural gas while NGPA extended price controls to intrastate gas (previously unregulated) and allowed for the phased partial decontrol of new and high-cost gas.

In 1979 market prices for gas were elevated by the oil shock. At the same time gas companies were contracting for long-term supplies in order to resume deliveries to curtailed customers. Many of these contracts contained provisions ("take or pay") that required the pipelines to pay for contracted volumes of gas whether or not delivery was actually taken.

By 1982, with world oil prices (and natural gas prices) softening, and demand diminishing, pipeline sales fell and the "take or pay" provisions were activated. In order to minimize the economic impact of these penalties, pipelines reduced their purchases of "old" or lower-priced gas. This created a surplus of deliverable supplies—"the gas bubble"—of approximately 2 trillion cubic feet and this surplus remains with us today.

## DISCUSSION ISSUES

**Repeal of the Fuel Use Act**

As a part of a larger effort to deregulate natural gas prices and to eliminate end-use restrictions, repeal of the Fuel Use Act is sought. Proponents argue that the threat of disruptive shortages of natural gas to residential customers has been effectively eliminated and that free market forces will ensure delivery of gas to its most highly valued use.

Opponents are prepared to repeal the demand restraints of the Act and to allow the user to choose the most economical fuel, be that oil, gas, or coal. Similarly, they are prepared to exempt industrial boilers and units used in peaking and intermediate utility service. They do insist, however, that units planned for base-load utility service be "coal capable."

Requiring that a boiler be "coal-capable" means that the boiler is designed to burn coal if necessary and that sufficient space is reserved for coal handling and pollution control equipment if needed. It does not require that the equipment be in place, nor does it require the plant to actually burn coal. It merely reserves the ability of the plant to convert to coal if economics indicate that to be the fuel of choice.

The issue—while seemingly straightforward—can cloud quickly in some instances. It has been utility practice for some time to use gas turbines for peaking power. Gas turbines are reliable, inexpensive, and can be quickly brought into service and taken out of service. They possess very stringent fuel specifications, however, in order to avoid damage to the turbine blades. Despite decades of research, gas turbines *per se,* can not be made coal capable. They must burn either distillates or gas. To burn coal would require the use of a coal gasifier and associated gas clean-up equipment.

With the addition of heat recovery boilers and steam turbines, a gas turbine facility can become a combined cycle plant. These units possess higher efficiencies than gas turbines alone and because of their larger sizes (400 to 600 MW) are well-suited to intermediate service. The Electric Power Research Institute (EPRI) is an advocate of the phased addition of combined cycle technology by utilities and proposes the following steps:

**Phase 1:** Addition of a 120 $MW_E$ (net) combustion turbine

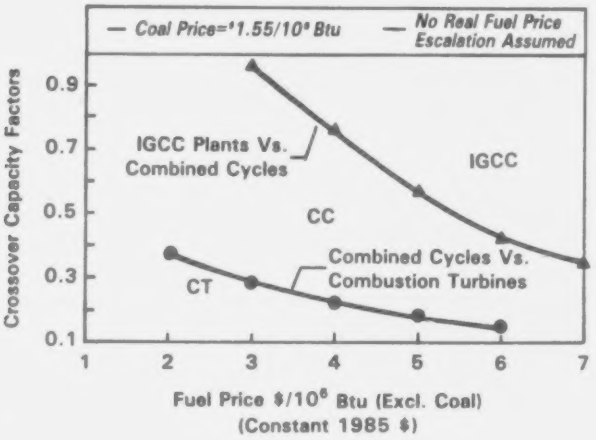
**Phase 2:** Addition of a second combustion turbine

**Phase 3:** Addition of a heat recovery boiler and a 120 $MW_E$ steam turbine

**Phase 4:** Addition and integration of a coal gasification plant

The relative economics of competing fuels and the utilities' demand for increasing power would govern the rate of implementation. For example, if coal cost $1.55/MMBtu and gas prices were $4/MMBtu, combined cycles (CC) would be preferred over combustion turbines (CT) for operation in excess of 2,200 hours. For operation in excess of 6,600 hours, coal gasification (IGCC) would be preferred over gas-firing for combined cycle operations. However, two concerns have been expressed about this implementation scenario.

## IGCC PLANTS VERSUS COMBINED CYCLES AND SIMPLE-CYCLE COMBUSTION TURBINES

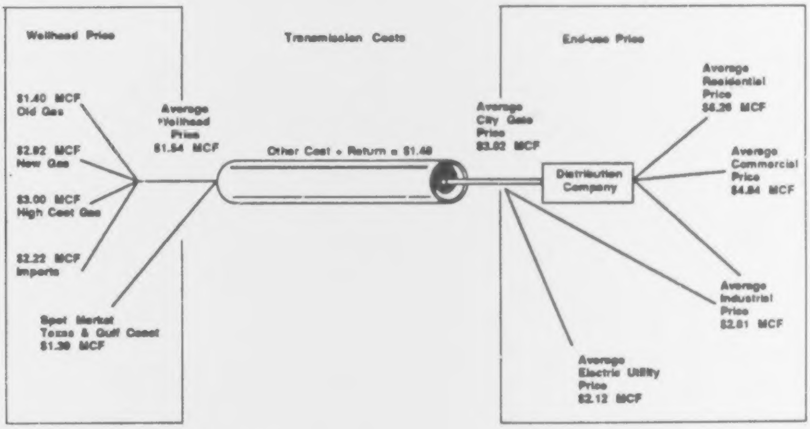


The first is the current regulatory climate governing utilities and their need to add additional capacity. Increasingly, regulatory commissions are refusing to allow utilities to recover capital or to earn profits if hindsight shows them to be "imprudent." This creates a bias toward low capital investment-high fuel cost alternatives even when the national interest might have been served with larger plants and lower priced fuels. In particular, as it relates to combined cycle plants, it is possible to envision utilities installing these units on natural gas (a very low-risk activity) and never converting to coal gasification (a much higher risk and capital intensive activity).

The second concern is that gas prices are not always what they appear to be. It is possible for a utility to be purchasing gas at a price below the cost of new gas or high cost gas and even below the cost of imports while the residential customer pays the difference. Figuratively, the residential consumer is left choosing between heat and lights and, in the event of a supply disruption, might literally have that choice made for him.

The proposed repeal of the Fuel Use Act raises questions concerning whether or not the marketplace would protect the residential customer's interest as the original Act was intended to do. Also, while coal-capable and base-load have particular meanings with respect to conventional boilers, their meaning is

## CONSUMER GAS PRICES ARE BASED ON MANY FACTORS
## (Prices Are From Fall 1986 Period)


Wellhead Price
$1.40 MCF Old Gas
$2.92 MCF New Gas
$3.00 MCF High Cost Gas
$2.22 MCF Imports
Spot Market Texas & Gulf Coast $1.30 MCF
Average Wellhead Price $1.54 MCF
Transmission Costs
Other Cost + Return = $1.48
End-use Price
Average City Gate Price $3.02 MCF
Distribution Company
Average Residential Price $6.26 MCF
Average Commercial Price $4.84 MCF
Average Industrial Price $2.81 MCF
Average Electric Utility Price $2.12 MCF

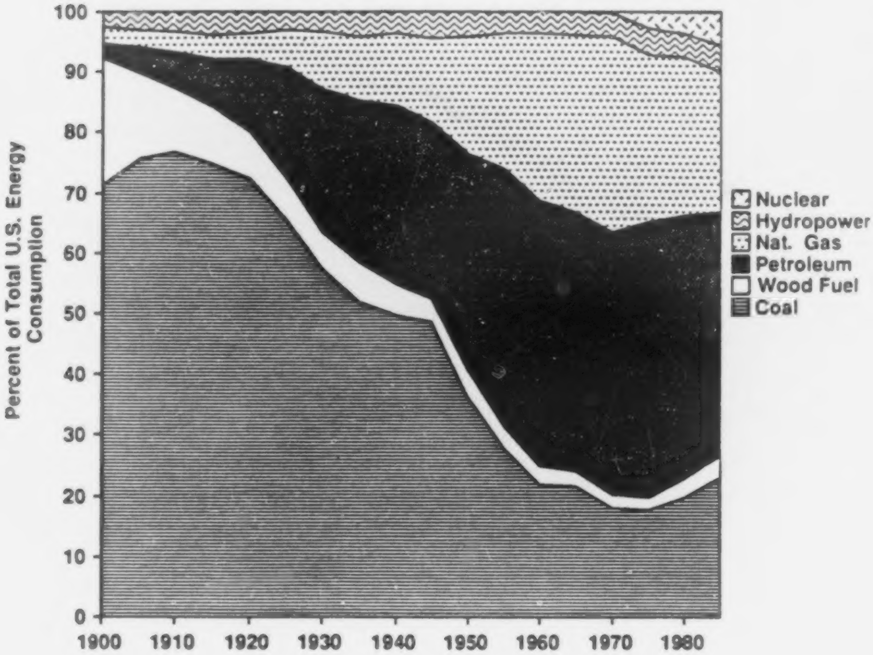
*Source: U.S. Department of Energy.*

less clear when applied to combined cycle power generating. Is additional clarity required? Finally, in light of increased scrutiny of utilities' investment decisions, are incentives or inducements required to move from gas-fired to coal-fueled combined cycles?

## The Role of Natural Gas in the National Energy Picture

Natural gas is clean, affordable, and possesses secure and ample reserves. It is also easily substitutable for oil in many applications. Is it wise to use it to displace coal in utility applications or is it more prudent to encourage its use and expansion in areas such as transportation where oil can be displaced? More generally, is it better policy to encourage maximum use of abundant fuels to displace scarce ones, or alternately, is it best to let the marketplace decide? What are the likely long-term effects of each approach?

## U.S. ENERGY CONSUMPTION BY FUEL SHARE



*Source: U.S. Department of Energy.*

- Oil comprises less than 3% of the recoverable U.S. fossil fuel reserves
- Natural gas comprises less than 4%, while
- Coal comprises nearly 80%.

Yet, consumption patterns do not reflect energy reserves and coal's role is limited primarily to two markets:

- Steam coal for power generation, and
- Metallurgical coal for steel-making

with the utility market being substantially greater than the steel market.

Coal's share in U.S. energy consumption has risen since 1970, brought about largely by the oil shocks of the 1970's leading to increased use of coal in new and existing power plants and the conversion of coal-capable plants to coal. Its future role in power generation is less clear, however, for several reasons:

- The use of coal is considerably more capital intensive than the use of oil or gas.
- Utilities are increasingly being required to absorb the risks of capital investments while passing the benefits on to consumers.
- Uncertainties concerning future environmental regulations raise the risks involved in using coal, and
- More stringent regulations raise the cost of using coal.

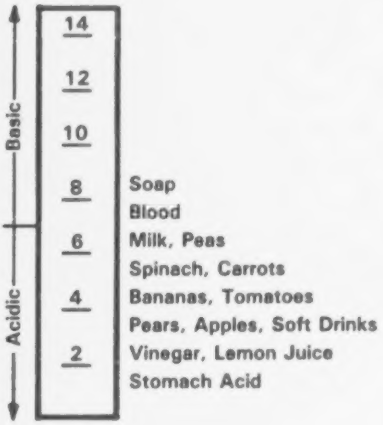
All of these factors operate to depress the price of coal relative to oil and gas. At the same time the coal producer faces:

- continuing pressures to increase wages and benefits for workers
- increasing regulatory pressure with respect to mining practice and safety
- a frequent lack of competitive transportation options
- a potentially dwindling share of a slowly growing market, and
- a continuing and growing threat from subsidized coal imports.

The coal producer typically supplies a single market, has little control over the price he can ask for his product, has limited control over his costs of production and transportation, and has no control over the regulatory climate pervading the industry.

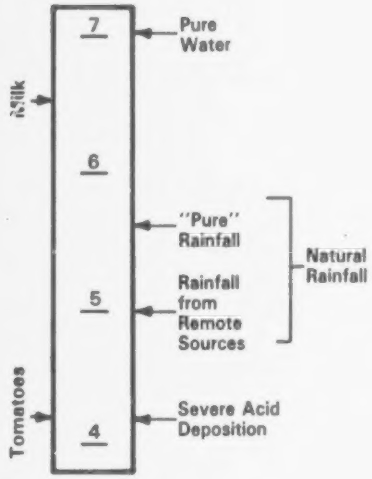
Perhaps the single greatest uncertainty with respect to the future use of coal is embodied in the issue of "acid rain." The name alone draws up images of destruction raining down upon us. It also underscores the differences in the public's perception of an acid and the scientific definition and use of the term "acid."

### The pH of Common Substances


Basic
Acidic
14
12
10
8
6
4
2
Soap
Blood
Milk, Peas
Spinach, Carrots
Bananas, Tomatoes
Pears, Apples, Soft Drinks
Vinegar, Lemon Juice
Stomach Acid

The scientific measurement that indicates the degree to which a substance is acidic or basic is called pH. The measure runs on a scale from 1, the most acidic, to 14, the most basic, with 7 being neutral. Chemically, pure water is neutral and therefore has a pH of 7. Few materials in nature are neutral, and in fact many natural substances have a pH below 7 and are therefore acidic. These include many foods and soft drinks, a number of which have a pH below 4, some even approaching a pH of 2.

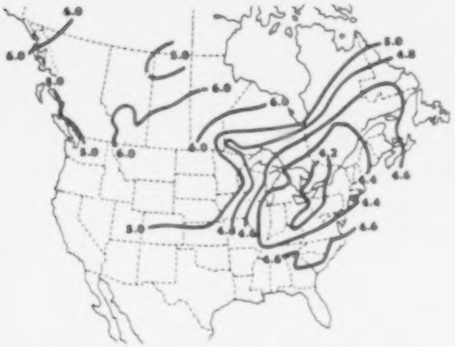
### The pH of Rainfall


7
Pure Water
Milk
6
"Pure" Rainfall
5
Rainfall from Remote Sources
Natural Rainfall
Tomatoes
4
Severe Acid Deposition

"Pure" rainfall is itself acidic with a pH of 5.6. This results from the rain being in equilibrium with atmospheric $CO_2$. Rainfall at sites remote from man-made pollution often has a pH approaching 5.

It is also true, however, that rainfall in areas of man-made pollution can have a pH near 4. It is this rainfall, the factors that create it, and its effects on the environment that have triggered national attention and debate.

### MEAN ANNUAL pH OF RAIN, 1979-1981



*Source: National Research Council, 1981.*

Most of the eastern United States has precipitation with an average pH below 5, with the most acidic (4.2) occurring in a narrow belt from southeastern Ohio into southern Canada. As the map at left shows, pH levels are lowest near the largest sources of air pollution. While the exact effects on the environment are unclear, U.S. and Canadian scientists agree that acid rain does not pose a direct threat to human health.

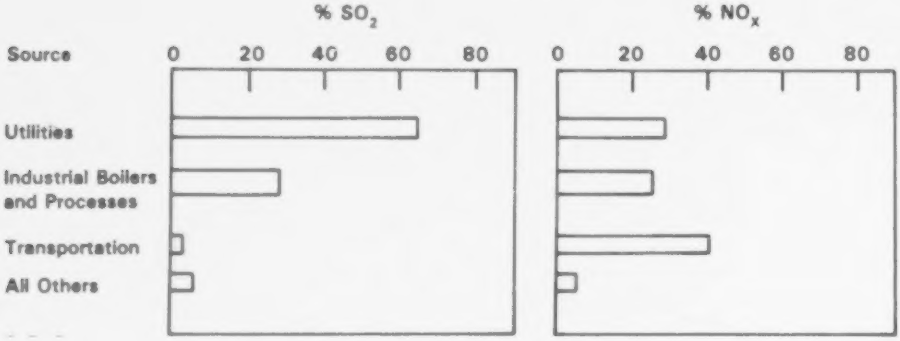
**Lakes**

The acidification of lakes, especially in Canada and the Adirondack Mountains, is thought to be due to acid deposition. The National Academy of Sciences, however, found that over the past 50 years, the pH of lakes in New York has, on the average, either stayed the same or become only slightly more acidic. Considering that causes other than acid deposition can also contribute to lake acidification, projections of tens of thousands of lakes being acidified unless emissions are reduced appear to be unfounded. Many scientists believe that few, if any, additional lakes will become acidic at current levels of deposition; that all the damage, to whatever extent it has occurred, has already been done.

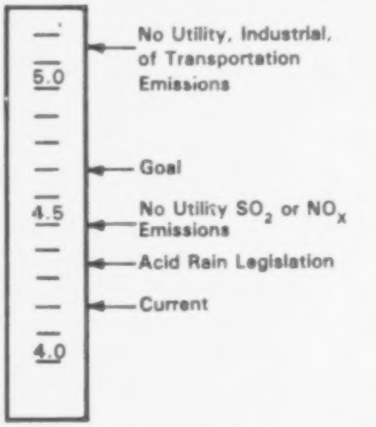
**Forests**

Forest damage has been observed in some areas and is often assumed to be due to acid deposition. A growing body of evidence, however, suggests that sulfur is not the cause. Scientists are coming to believe that the damage is related more to the deletrious effects of ozone than to acid deposition. Ozone is formed through the reaction of $NO_X$, hydrocarbons, and sunlight. Ozone is known to affect crops and trees at current levels. The effects of acid rain are unknown.

## DISTRIBUTION OF U.S. $SO_2$ AND $NO_x$ EMISSIONS BY SOURCE



Acid deposition is caused by a host of transported air pollutants, with $SO_2$ and $NO_x$ being the most conspicuous—but not the only—contributors. Since utilities are major emitters of both of these, control of utility emissions is widely believed to be the key to solving the acid rain problem. Two questions need to be examined: (1) To what extent is acid rain—or more appropriately, acid deposition—a true environmental problem? and (2) To what extent will regulating utility emissions contribute to solving the problem?



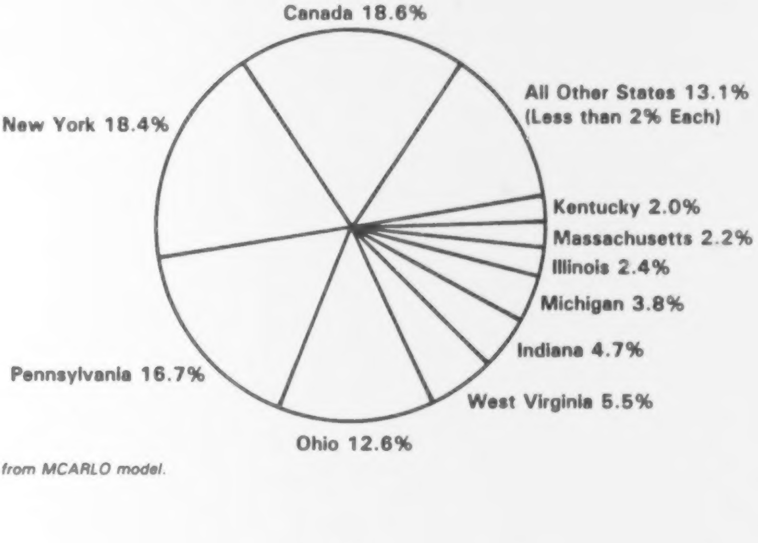
The National Academy of Science has suggested that a pH of 4.7 is necessary to protect sensitive aquatic ecosystems from environmental stress or damage. This goal provides a measure against which to gauge the effects of various air pollution control strategies insofar as they are supposed to address the matter of acid rain and its consequences.

Researchers at MIT have concluded, for example, that if current acid rain legislation were implemented, the pH in affected areas would be raised from its current 4.2 to about 4.35. Such a change would result in improving visibility, a lessening but not elimination of acidic burden on watersheds and lakes, but probably no perceptible improvements in crop or forest damage. Even the total elimination of utility $SO_2$ and $NO_X$ emissions would fall short of the goal of 4.7 and raises the question of whether liming sensitive lakes would be a more effective strategy.

The predicted effects of the legislation also raise a warning against unrealistic expectations. They point out that achieving national goals for improving air quality and reducing acid deposition through emission controls will require regulating more than utilities and the control of additional pollutants beyond $SO_2$ and $NO_X$. To prevent continuing damage to forests and crops will undoubtedly require the reduction of $NO_X$ emitted from automobiles and controls on hydrocarbons. These considerations raise serious questions about how much capital should be invested to achieve a small increase in pH levels and hence whether there are ways to get more out of each dollar spent. In other words, the critical question is not whether to reduce air pollution, but rather how, when, and where it is best to invest valuable capital to do so.

Research clearly shows, for example, that the most effective means of reducing the acidity of rain falling on a sensitive area is to reduce emissions closest to the area. An MIT study estimates that reducing emissions in New York is ten times more effective in reducing acid deposition in the Adirondacks than the same reductions in Florida.

## ORIGIN OF THE SULFUR THAT FALLS ON THE ADIRONDACKS



*Source: Data from MCARLO model.*

Similarly, while New York and Kentucky have similar $SO_2$ emissions, it is estimated that New York contributes more than 9 times the sulfur deposits in the Adirondacks than does Kentucky. Thus, if an emission reduction strategy is to be pursued in controlling acid deposition, the most effective use of capital would require its increased expenditure at sources near to sensitive areas and decreasing expenditures at more remote sources.

How best to reduce $SO_2$ and $NO_x$ emissions from these sources and how rapidly to achieve these reductions are two important unanswered questions. While it is possible to relate acid deposition to power plant and other emissions, the relationships between acid deposition and environmental damage are unclear at best. In the absence of such relationships, cost/benefit analyses cannot be performed with any confidence nor can the effectiveness of alternate mitigation strategies be established.

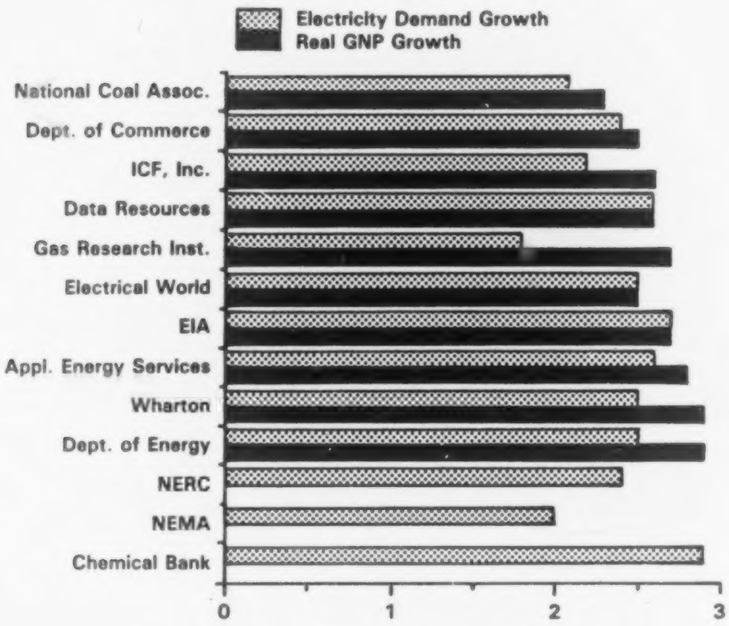
In spite of this, some comparisons can be drawn as to the effectiveness of various strategies. First, the Clean Air Act is working and while coal consumption has increased, $SO_2$ and $NO_x$ emissions have decreased. Further reductions will be achieved as aging capacity is replaced with new capacity conforming to more stringent standards. Offsetting this, however, will be increases in demand which will require new capacity and hence additional emissions.

Legislation has been proposed and is pending which would require immediate reductions in emissions by 1995. Costs associated with doing this are not known with certainty and estimates have been highly variable. Costs in the range of $50-100 billion are most frequently cited. Accompanying this are also social and employment impacts of considerably varying magnitude.

Finally, clean coal technologies can be deployed which, when demonstrated, will form the basis for more stringent standards and thus even further reductions in emissions.

In assessing the emission reductions possible under various strategies, certain assumptions have been made. The first of these is that the growth in U.S. electrical demand will be 2.5% per annum.

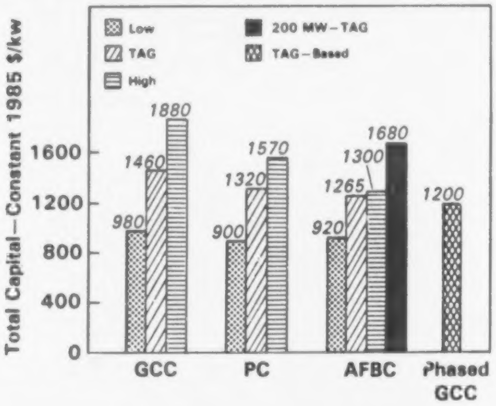
## PROJECTIONS OF U.S. ECONOMIC AND ELECTRICITY DEMAND GROWTH RATES
## (Average Annual Growth, In Percent, 1985-2000)



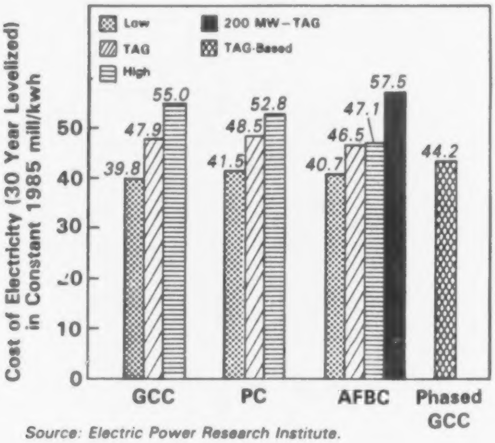
· *Sources:* *National Coal Association, "Coal 2000," March 1986; U.S. Department of Commerce, Joseph F. Gustaferro, "U.S. Energy for the Rest of the Century," July 1985; ICF, Inc., from Edison Electric Institute, "Electric Perspectives," Spring 1986; Data Resources, Inc., "U.S. Long-Term Review," Spring 1986; Gas Research Institute, "1985 GRI Baseline Projection of U.S. Energy Supply and Demand to 2010," November 1985; Electrical World, "37th Annual Electric Utility Industry Forecast," September 1986; U.S. Energy Information Administration, "Annual Energy Outlook 1985," February 1986; Applied Energy Services, Inc., "U.S. Electricity Markets in the 1990's," Testimony prepared for the Committee on Energy and Natural Resources, U.S. Senate, July 25, 1985; Wharton Econometric Forecasting Associates, "Long Term Forecast," December 1985, and conversation with Jeffrey Shapiro, U.S. Services Division; U.S. Department of Energy, "National Energy Policy Plan Projections to 2010," Preliminary 1987 Reference Case, September 1986; National Electrical Manufacturers Association, "Tenth Biennial Survey of Power Equipment Requirements of the U.S. Electric Utility Industry 1985-1994," March 1986; and Chemical Bank, "U.S. Electric Utility Industry Outlook to the Year 2000," February 1984.*

Most sources place this figure between 2 to 3% with 2.5% probably being a little high. This leads one to calculate slightly higher emissions. Aging capacity is assumed to be retired and replaced after 40 or 50 years. This ignores plant life extension programs and repowering options and thus probably leads to higher estimates of capital investment. Retired plants are assumed to be replaced with either IGCC capacity at $1,460/kw or advanced PC/FGD systems at $1,320/kw with the investments expressed in 1985 dollars.

CAPITAL INVESTMENT ESTIMATES FOR SINGLE 500 MW UNITS (AFBC HAS ONE 200 MW UNIT CASE)

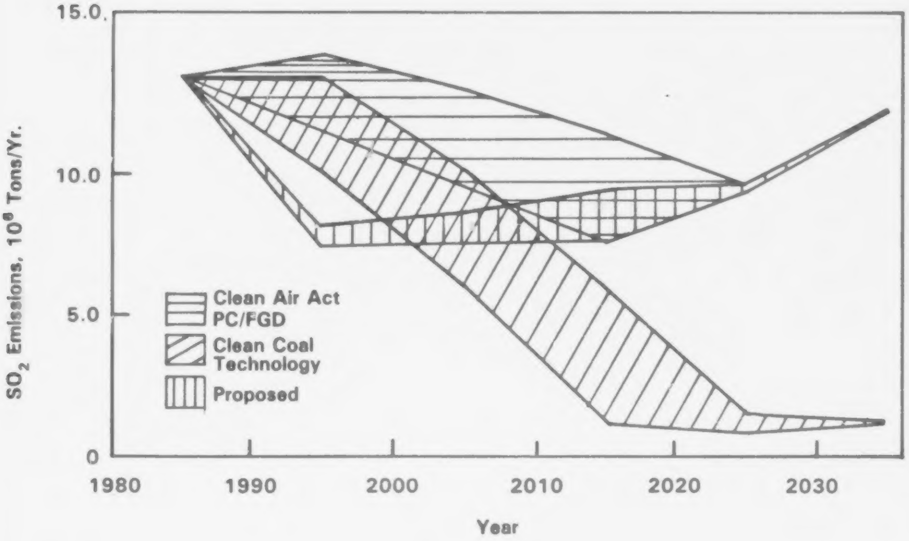


COST OF ELECTRICITY ESTIMATES USING TAG ECONOMIC CRITERIA



*Source: Electric Power Research Institute.*

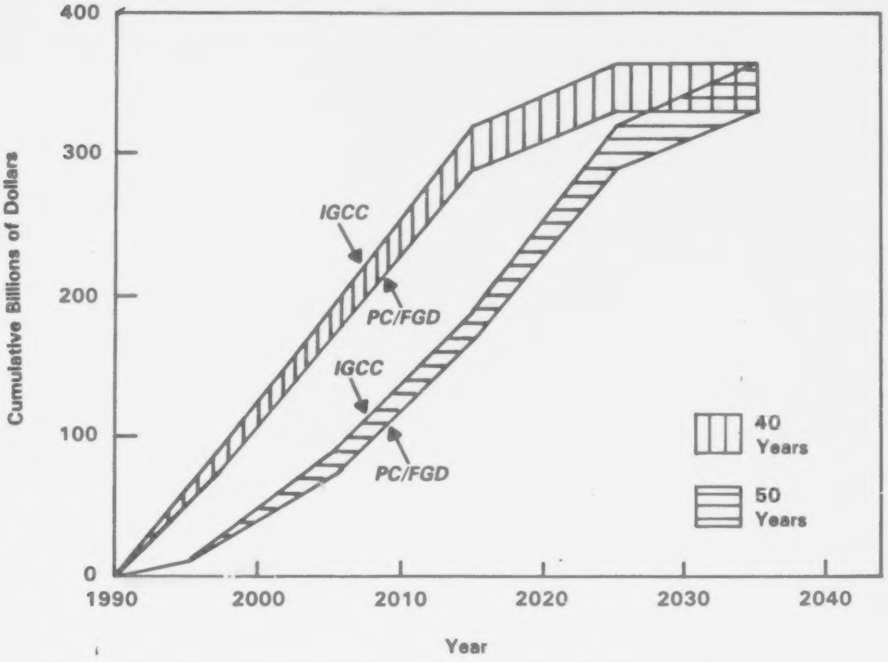
This is not to shun the role that fluidized bed combustion (FBC) or other clean coal technologies might play, nor is it an endorsement or recommendation of any particular technology. The intent is simply to indicate broadly the emission reductions and costs which might be associated with a particular reduction strategy.



VARIOUS $SO_2$ REDUCTION STRATEGIES

While there are differences in various proposed acid rain control bills, most propose significant reductions in $SO_2$ and $NO_x$ by around 1995. Thus, the "proposed" curves above show the $SO_2$ emissions which would result in a 31-state area if all existing utility capacity were to conform to a 1.2 lbs $SO_2$/MMBtu standard by 1995. New capacity is assumed to come on-stream conforming to a 0.6 lbs $SO_2$/MMBtu standard. The lower curve corresponds to a 40 year life to retirement, the upper to a fifty year life. The "Clean Air Act" curves show the reductions achievable by retiring aging plants after 40 or 50 years and replacing it with plants needing a 0.6 lbs $SO_2$/MMBtu standard. The lower set of curves labeled "clean coal technology" show the reductions possible using IGCC plants conforming to a 0.06 lbs $SO_2$/MMBtu standard. This represents the cleanest of the available technologies. Other clean coal technologies would be intermediate to this and the "Clean Air Act" curves.

## CAPITAL COSTS OF VARIOUS $SO_2$ REDUCTION STRATEGIES FOR REPLACING EXISTING PLANTS



The cumulative capital investment required for replacement of existing plants is shown above for retirements after 40 and 50 years respectively. The upper curves are for IGCC plants, the lower for PC/FGD facilities. The costs for FBC, repowering, and life extension options are reported to be lower than these, with the emission reductions being intermediate to these two cases. For both sets of options, the increased costs by the year 2000 associated with an early retirement at 40 years as opposed to 50 years is about $100 billion—the same magnitude as that estimated for the proposed reductions. Roughly comparable reductions are achieved in all cases around 2010.

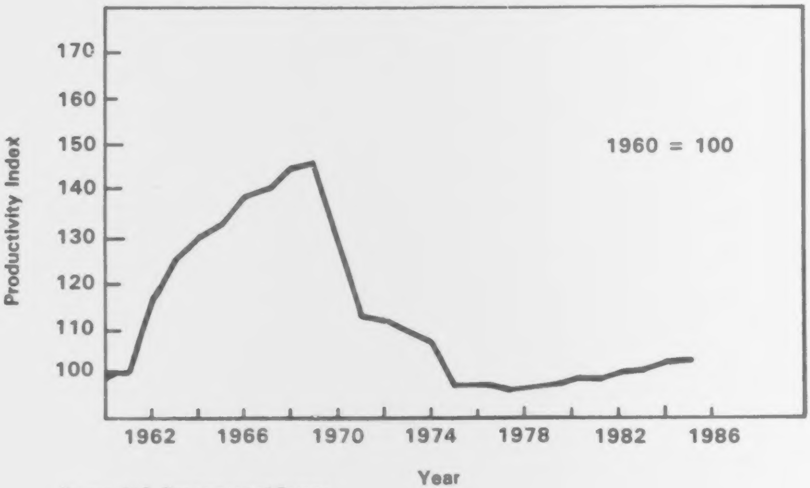
## DISCUSSION ISSUES

- Is the acid rain problem so urgent as to warrant immediate controls?
- If controls are warranted, should the program focus on sulfur dioxide first, or include nitrogen oxides and hydrocarbons as well?
- If controls are warranted, what mix of options is appropriate?
- How should the costs be distributed and how should they be financed?
- Are time and money used to better advantage by providing incentives to accelerate the deployment of clean coal technologies?
- If so, what technologies?

While acid rain legislation is a serious problem facing the coal industry, other issues are of immediate importance as well.

The regulatory programs of 1969 and 1977 have had substantial impact upon productivity. This can most clearly be seen in the productivity indices for underground mines.

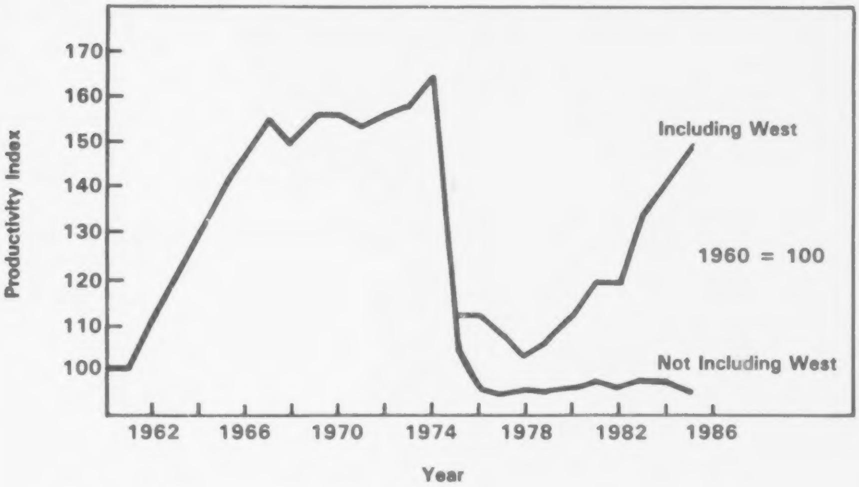
UNDERGROUND MINING PRODUCTIVITY, 1960-1985



*Source: U.S. Department of Energy.*

Prior to the Coal Mine Health and Safety Act of 1969, productivity from underground coal mines was increasing strongly each year. The implementation of the very detailed provisions of the Act concerning primarily dust control, ventilation, and roof control coincided with a drastic drop in productivity. Largely an extension of the 1969 Act, the Mine Safety and Health Act of 1977 appears to have had much less impact except for possibly slowing the rate of productivity recovery. From the mid-1970's to the present, coal producers have been striving to improve productivity in underground mining. It is generally agreed that the costs of the 1969 and 1977 Acts have been internalized, and underground mine productivity is steadily, if slowly, improving.

## SURFACE COAL MINING PRODUCTIVITY, 1960-1985



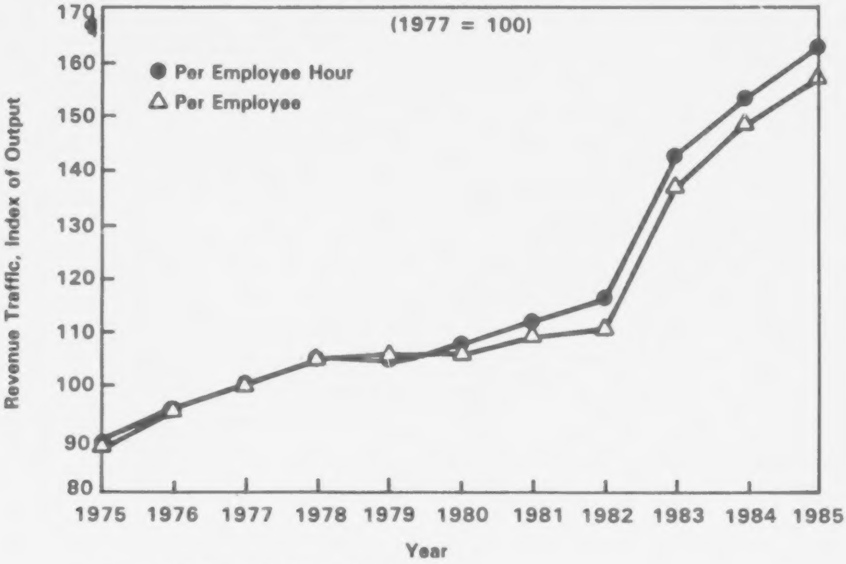
*Source: U.S. Department of Energy.*

The impact of regulation upon surface mining is not as easily determined. There was a drastic drop in surface mining productivity in 1975, just preceding the 1977 Surface Mine Control and Reclamation Act. This was due largely to the oil embargo coal boom during which dramatic price increases led to very inefficient crash-style mining. Second, the apparent upsurge in surface mining productivity beginning in 1978 is attributable to the boom in surface mining in western states, where gentle terrain and very thick coal seams yield much greater productivity than in the east or midwest. In 1985, for example, western average productivity was 460 percent that of the Appalachian Coal Region and 313 percent that of the Interior Coal Regions. Surface mining areas other than in the west show very little productivity growth since 1977.

The coal industry faces low and decreasing prices for coal and steadily increasing costs of labor, equipment, and fees. The tax burden also continues to grow. Therefore, productivity improvement is imperative. To a large extent, the added costs of regulatory programs have been internalized; however, the costs are substantial.

Transportation costs, particularly rail rates for hauling coal, have become a major issue in the competitiveness of U.S. coal in domestic and foreign markets. The cost of transporting coal by rail can be a substantial part of the delivered cost. In western states, where production costs are generally low and from which distances to markets may be large, transportation can account for the greatest part of delivered price. In recent years, concern over rail rates has grown as the delivered price of coal has steadily declined.

## INDEX OF RAIL PRODUCTIVITY, 1975-1985



*Source: U.S. DOL, BLS, Office of Productivity.*

Deregulation is encouraging competition among railroad companies and between rail and other transportation modes. Since 1980, overall productivity has increased substantially. Unit-train service is being rapidly expanded. Some railroads are offering incentive rates to reduce load-out times and the number of load-out points. Others are developing transportation packages which offer transportation mode combinations, particularly rail and barge, worked out by the railroad for the shipper. Also, competition among transportation modes is increasing.

Railroad deregulation is encouraging major changes in the ways in which producer, transporter, and consumer arrange for rail shipment of coal. The Staggers Act allows rail rates and other service items to be negotiated through contracts between transporters and shippers. In much the same way that the unit-train concept improved planning for railroads and created economies for shippers through guaranteed volumes and equipment dedication, the negotiation of contracts offers opportunity for combining specific demand, production, and transportation most effectively for all parties.

The benefits of contract rates may be diminished by today's weak prices for coal. As coal prices have decreased, major consumers have purchased more coal on the spot market and on shorter-term contract. This trend is expected to continue as current coal prices remain low. In the 1990's numerous large long-term contracts are due to expire. Decreasing coal prices and excess production capacity will discourage the signing of contracts long enough in term to be most conducive to the most efficient development and allocation of resources and equipment by producers and transporters.

## DISCUSSION ISSUES

Railroad issues continue to be intensely debated. In the 99th Congress, a coalition of coal producers and consumers sought legislation to refine the Staggers Act; the stated goal was to retain the features of the Act which enabled railroads to earn an adequate return on investments while providing for continuing regulation where competition is not effective. During this debate, some actions have been taken, including:

- Judicial revoking of the exemption of rail rates for export coal from ICC jurisdiction;
- Revision of geographic and product competition standards to be used in determining market dominance; shifting of burden of proof to rail carrier to show that competition exists in a complaint over market dominance;
- Revision of rules concerning competitive access (i.e., use of a railroad company's track by another railroad company), especially in requirements for adequate notification and justification for cancellation of access privileges;
- ICC allowance for rate rollbacks in the quarterly rate adjustment which is calculated by the ICC and extended automatically to railroads;
- Establishment of a Railroad Accounting Principles Board (RAPB) to help devise a sound and agreed-upon method of measuring railroad revenue adequacy; a recent draft report from RAPB recommends several changes which have been sought by shippers.

Additionally, whether it be in transportation or mining, regulation can affect productivity either positively or negatively. Safety training has contributed to greater productivity and the benefits to society are clear. On the other hand, some reclamation regulations have added to the cost of production and the benefits to the environment and to the public are less than clear. To the extent that regulation is adversarial, productivity is diminished. Worse still, potential benefits to both the regulator and the regulated can be overlooked. Is it appropriate to review the entire regulatory structure facing the industry with an eye toward removing counterproductive, punitive, and ineffective regulations? Should some form of cost-incentives or other approaches be adopted to encourage producers to develop innovative and cost-effective solutions to problems? Or, since the costs of present regulations have been internalized, is it better to leave well enough alone?

Senator FORD. Let me ask you just a little bit about how the current State and/or Federal regulations governing the utility industry impede the commercialization of clean coal technologies.

Some—as you may know—utility regulations are promulgated at the State level. How would Federal regulatory changes facilitate the commercialization of clean coal technologies?

Mr. EVANS. I feel, Mr. Chairman, that this could be an improvement because we have the regulations. I don't think any—there are probably no two states that are alike with their regulations.

It would strike me that if we had more uniformity within our public service commissions and interactions, we could get far better results.

I think that this is probably true to the point that with some of the advances that we can have in technological improvements, we do not necessarily have those—We do not necessarily have the technological—long-range technological value accepted by the public service commissions.

But I think that with the plans, programs, and research which Senator Byrd mentioned that I can certainly say that I was very excited about his testimony. I thoroughly support Senator Byrd's approach, and I think with the Federal incentives, why it gives us a great opportunity to reduce risks.

Senator FORD. You mentioned the Governor of the State calling in all those from around the country to discuss the possibilities of coal in your Coal Summit II. What would be the difference in the discussion under Summit II than you had under Summit I?

Is there any change of attitude, any new technology? What would be a different arena, or is it basically the same as we struggled with under Summit I?

Mr. EVANS. Well, I think some of the problems of the nation and the industry are essentially the same. To a large degree, I think we've advanced. We've certainly developed a tremendous interest in Coal Summit II.

We will have over twice as many CEO's of the coal industry, the utilities, the railroads and government people attending this second summit; and we would probably would have many more if we were not having it on Good Friday.

But my reading on it is that there are many individuals in the public and private sectors who want to achieve conclusions like energy independence, decreased reliability on foreign oil, the balanced use of our resources and balance to the environment.

That is what we intend to accomplish at Coal Summit II. We do this in the context of being allies in a common cause. This is the goal.

We're grateful for the fact that it is the interest of people like you, Mr. Chairman, and I know that Senator Johnston of Louisiana has an interest. Senator Byrd is going to participate in the Summit, along with Secretary Harrington, as well as the heads of Chevron, Consolidation Coal, CSX, and the Southern Company.

As a matter of fact, the attendees are going to be quite a long list of really the top people of Government, and all the components of our Nation's energy establishment all meeting together, sleeves rolled up and attempting to come up with some things that would be worthwhile for the Congress of the United States.

Senator **Ford**. One last question, Mr. Secretary.

Senator Byrd has said in his statement that a long-range study to find and develop new technologies is the best route to go, rather than to impose immediate enactment of an acid rain bill.

In your mind, what benefits derive from encouraging the development and commercial use of clean coal technologies, as opposed to immediate enactment of an acid rain bill?

Mr. **Evans**. I think, Senator, it is extremely important; I think with the things that we've learned about acid rain—and I certainly agree with Senator Byrd. I don't think there's something here where we need something that has the appearance of a quick fix.

I think we have to do something far better than scrubbers. And a good example of what—the one thing that looks awfully good, as far as advanced technology, is the Cool Water plant in California.

That's the Integrated Gasification Combined Cycle. The results of this plant, the emissions are practically nill in sulfur dioxide and very, very low in nitrous oxides.

It strikes me that if we're going to keep all of my fishing lakes clean, we could use a lot of combined cycles throughout this nation. But you can't do it overnight.

I don't think we're in a position in this country for an instant answer or an instant fix.

Senator **Ford**. Thank you, Mr. Secretary. I appreciate your coming today and giving your statement; and I'll look forward to visiting with you at Coal Summit II.

There may be some significance to Good Friday. This may have the blessing on it, as we attempt to find some answers.

Thank you very much, Mr. Evans.

I am going to call the next three witnesses separately and then ask them, as they arrive at the table to give their testimony, and that they remain at the table so that we might ask them questions collectively.

So, Dr. Balzhiser of EPRI, if you will come forward, we'll hear your testimony; then Joe Dowd and Bob Wise will follow in that order.

## STATEMENT OF DR. RICHARD E. BALZHISER, SENIOR VICE PRESIDENT, RESEARCH AND DEVELOPMENT, ELECTRIC POWER RESEARCH INSTITUTE

Dr. **Balzhiser**. Good morning, Mr. Chairman.

Senator **Ford**. Like the other witnesses, if you wish to submit your statement in total, it will be in the record; and if you want to highlight it, that will be fine; however you want to proceed.

We are constrained a little bit for time this morning, but I don't want to jeopardize the hearing. If you'll wait for me, I'll come back, if we get called away.

Dr. **Balzhiser**. Thank you. I intend to do that.

I am Richard Balzhiser, Senior Vice President, Research and Development, of the Electric Power Research Institute.

I appreciate this invitation to discuss the status of clean coal technology development and the importance of Federal support in accelerating its commercial availability and widespread deployment.

EPRI, supported by investor-owned, government-owned and cooperatively-owned electric utilities across the nation, has been a major contributor to the highly successful development efforts of the last 12 years.

In addition to the $700 million invested to date by EPRI on this effort, our staff has made significant individual contributions to refining these technologies for utility use. Furthermore, we expect to spend about a third of our budget over the next five years on Clean Coal Technology.

In my remarks today, I will first focus on the importance of Clean Coal Technology and, secondly, at your request, I will present a status report on our state of knowledge about the transport and effects of sulfur and nitrogen emissions.

EPRI's development objectives for improved coal power generation technology over the last decade have taken a holistic approach with respect to environmental and resource considerations.

We've anticipated the toxic concerns of today and the water shortages of tomorrow, in defining systems that can use all types of our abundant coal resource economically in generating electricity. The clear winners in this competition in our judgment are Fluidized Bed Combustion and Integrated Gasification Combined Cycle.

These technologies internalize emission control of sulfur and nitrogen, and thus avoid the costly and complicating problems of scrubbers. These technologies offer a modular coal option for new capacity, and appear to have repowering potential for existing fossil fuel generation capacity.

Our optimism has been reinforced by the initial demonstration scale deployment of Gasification Combined Cycle at Cool Water on the Southern California Edison system and the Fluidized Bed Combustion demonstrations at Northern States Power, Colorado Ute and TVA.

These development and demonstration efforts have been undertaken collaboratively with our member utilities, equipment suppliers and the federal government. The technologies are now awaiting commercial demonstration commitments to verify performance refinements and obtain the experience necessary to optimize designs and reduce costs.

The risk is at a maximum in this stage of the technology maturation process, and no utility or supplier is prepared to assume it alone. Given the potential benefits that clean coal technologies portend for the environment and the consumer, we believe Federal risk sharing is both justified and necessary to accelerate commercialization.

However, we must not overlook the importance of the continued reliable operation of older coal-fired plants to the nation's economic health. Repowering will not meet the needs of all these plants.

Scrubbers pose even more difficult problems for retrofit applications than for new plants, and thus we have been attempting to develop alternative retrofitable technologies for controlling sulfur and nitrogen oxides, should they be necessary.

The demonstration of these technologies is absolutely essential because of the risk they represent to the sizeable existing plant investments. These additional options typically provide alternatives that trade capital cost for operating cost, and removal levels below those achievable by scrubbers for lower overall costs.

Hopefully, their use will not be extensive, and we can transition into a clean coal era building on our evolving experience of Integrated Gasification Combined Cycle and Fluidized Bed Combustion to maintain the continued decline in $SO_2$ emissions.

Mr. Chairman, I turn now to the issue of acid deposition. Since its inception in 1973 EPRI has developed a substantial and continuing research program on the environmental implications of utility activities, including the health and ecological effects of ambient air pollutants. Our funding of these efforts is second only to the U.S. Government.

Over the past ten years we have seen a significant change in our knowledge regarding acid deposition and a convergence of scientific opinion on what we know and do not know. This convergence of scientific opinion and change in attitude to one of reasoned concern, stems in large part from the emerging results of research, from research programs started eight to ten years ago which are now providing data on the nature and extent of acid deposition and its effects.

We still face many uncertainties. However, new data are coming forth regularly, and private industry and the government have cooperative research programs underway that we believe will reduce considerably the remaining uncertainties.

Let me summarize briefly some highlights of what our technical staff at EPRI believe to be the scientific consensus on the environmental effects of acid deposition.

The acidity of lakes is largely determined by surrounding soil and geologic conditions and their buffering capacity. The EPA Western Lakes Survey found no acidic lakes in the western states, except for one in Yellowstone Park attributed to a hot spring.

And from EPA's survey of soil conditions in the Northeast, to quote EPA director of R&D, Courtney Riordan, from the March 26 issue of the Wall Street Journal—and I quote:

> It appears to indicate that the Northeast is in a steady state. . . . You cannot make a prediction that further acidification will occur at current loads.

Studies by EPRI in the Adirondacks, in Sweden and by others show that liming is a cost-effective mitigation strategy for restoring aquatic communities to acidic lakes. And research so far finds no long-term ecological problems from liming.

Forest decline, a more recent concern, has received much attention recently in Europe and in eastern North America. In the United States, red spruce appear to be in decline at some high elevation sites, but not at low elevation sites or in the Southeast.

The cause of the decline is not known. We are actively sponsoring major forest research programs, along with NAPAP and the forest products industry.

Our research has addressed not only environmental effects of acid deposition, but also the physical and chemical processes of its formation and transportation. In our judgment it is essential that we better understand whether we can influence deposition measurably in the Northeast by the billion dollar expenditures proposed to be scattered over the eastern United States.

Progress here is slower as atmospheric processes are extremely complex. We're working collaboratively with the U.S. and Canadian governments to develop and test more sophisticated models for predictive purposes.

Validation of these models requires extensive data which we are collecting from stations across the North American Continent.

Mr. Chairman, I am confident that the research at EPRI and other organizations will continue to provide invaluable information about acid deposition, how it is formed and what environmental effects it may have, as well as those it probably does not have.

In my opinion, continued emission reduction through demonstration and commmercial deployment of Clean Coal Technology should provide the margin of confidence desired by environmentalists in protecting our natural resources without compromising the productivity of our economy and our power plants and with minimum likelihood of creating still other environmental concerns.

Mr. Chairman, with your permission, I would like to submit for the record a separate document that provides more complete details of our findings on both the Clean Coal Technology and acid deposition.

Senator FORD. It will be included in the record.

[The prepared statement of Dr. Balzhiser follows:]

# TESTIMONY TO

Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources
U.S. Senate

By Dr. Richard E. Balzhiser

Senior Vice President
Research and Development
Electric Power Research Institute
Palo Alto, CA

APRIL 2, 1987

## INTRODUCTORY STATEMENT

Mr. Chairman, Members of the Committee: I am Richard E. Balzhiser, Senior Vice President, Research and Development, of the Electric Power Research Institute (EPRI).

I appreciate this invitation to discuss Clean Coal Technology and Acid Rain Programs. Clean Coal Technology has important implications in not only reducing emissions contributing to acid rain but also in improving the overall perforamnce of coal fired power generation with lessened overall impact on the environment. These latter considerations lead the enthusiasm we espouse for Clean Coal Technology, particularly the Fluidized Bed Combustion and Integrated Combined Cycle options for new or repowering deployments.

EPRI was established by the electric utility industry in 1972 to conduct a broad research and development program for the entire electric utility industry and its customers. EPRI's R&D mission is to develop new and improved technologies for electric power production, delivery and use, and a scientifically sound basis for assessing environmental issues.

EPRI is supported by voluntary contributions from investor-owned, government-owned and cooperatively-owned electric utilities across the nation. Over one-third of EPRI's planned budget in the next five years will be directed to Clean Coal Technology. This is in addition to the $700 million already invested by EPRI on this effort. This commitment is based on the premise that coal utilization and environmental protection are mutually compatible and that improved technology is the key to compatibility. In addition, sound scientific data derived from independent, peer-reviewed research must be developed in a timely manner on topics of environmental concern. We have been conducting research on the effects of acid deposition for over 10 years at EPRI. Our "effects" research, alone, has involved expenditures in excess of $60 million, and we continue to spend about $10 million per year on research which addresses acid deposition research.

In my remarks today, I will first focus on the need for Clean Coal Technology, the status of the technology options and demonstration requirements; second, I will present a status report on our state of knowledge about the transport and effects of sulfur and nitrogen emissions. I will conclude with some summary remarks. A comprehensive set of references, and an appendix providing detailed descriptions of clean coal technologies are also provided.

# Part I

# CLEAN COAL TECHNOLOGY

## I. CLEAN COAL TECHNOLOGY

Current environmental control capabilities must be improved by reducing capital and operating costs and preserving overall plant productivity. The importance of this effort is underscored by the fact that a new, large, conventional coal-fired power plant will typically cost $1.5 billion, with over 30% of this cost being directed toward environmental control. This includes sulfur dioxide ($SO_2$) scrubbing, particulate control, solid waste disposal, water treatment and plant cooling. These controls in their current form also have a major impact on plant efficiency and reliability.

The emission control debate has been driven by conflicting perceptions about the effectiveness of clean air programs. Since 1973, these programs nationwide achieved a 26% reduction in $SO_2$ emissions while utility coal use increased 70%. In addition, EPRI analyses conclude that $SO_2$ emissions will continue to decline under the existing Clean Air Act. In spite of the progress achieved, the political focus is shifting from new sources to the more difficult problem of existing facilities. In essence, the debate concerns which sources should be required to further control emissions, by what means, and at whose expense.

The growing understanding of the complex interaction among pollutants indicates instead that the nation should be concentrating on developing an effective, sustained strategy to continue the substantial progress made in all aspects of emissions control. Especially important is vigorous application of new, clean coal utilization technologies that combine emission control with the combustion or conversion process. The utility industry has led the nation in developing and applying Clean Coal Technology, thus strengthening the likelihood of using coal cleanly in every respect this century.

Recommendations in the recent "Joint Report of the Special U.S./Canadian Envoys on Acid Rain" (The Lewis/Davis Report) reflects this change. First, environmental protection can best be achieved through use of innovative Clean Coal Technology rather than ineffective, "band-aid" plant modifications that compromise both productivity and the environment. Second, accelerated commercial demonstration and implementation of these technologies by regulated utilities will require cost-sharing and other incentives not available today. Third, continued research is required in the ecological and atmospheric sciences to better understand cause and effect relationships.

This is a symbolic change in approach and one which provides an opportunity for a positive solution, building on the utility industry's sustained commitment to resolution of the environmental and economic productivity challenges facing the nation.

Since its inception, EPRI has worked with the Department of Energy (DOE) and its predecessor agencies, the Environmental Protection Agency, and other Federal agencies with energy research and development responsibilities to achieve mutual technical objectives. In the spirit of that long-standing cooperation, EPRI and others recommended an accelerated national program to better understand the environmental issues constraining the use of coal and to demonstrate and promptly apply promising new Clean Coal Technology. This effort would build on activities already underway within the federal and private sectors. It recognizes that a major pacing issue in commercial applications of the new clean coal technologies developed over the past decade is the magnitude of the resources necessary to confidently demonstrate their performance and reliability. This requires an intensive, joint effort by industry and government. My remarks today focus on two principal aspects of this national Clean Coal Technology program; viz.,

1. Why Clean Coal Technology?
2. Clean Coal Technology status and demonstration requirements.

## WHY CLEAN COAL TECHNOLOGY?

The principle which guides Clean Coal Technology development is that sustained environmental improvement can only be achieved when both emission and cost reduction are achieved concurrently, not pitted against each other. Recognizing this principle, the utility industry, which uses over 80% of U.S. coal production, stands at a threshold of fundamental change in its technological base for power generation. The present commercial coal-fired technology is nearing the end of its development potential and is hard-pressed to respond effectively to the rapid changing requirements being placed on power plants. New power generation options which can meet increasingly stringent siting and environmental demands without sacrificing productivity, and can be rapidly constructed in modular fashion over the range of unit sizes are particularly in demand. The next 10 years will therefore be of paramount importance, both in assuring future electricity supply and in controlling cost. It is in the strategic interests of the utility industry, the environmental community, and Government alike to assure the success of this national program.

These changing institutional constraints have effectively priced new conventional coal-fired generating capacity out of the market for most utilities. For example, it costs three times more today in constant dollars to install a kW of conventional coal-fired electric generating capacity than in 1967. Only a fundamental improvement in power plant technology can effectively respond to these growing constraints on coal-fired power generation and restore economic progress in electricity production. Clean Coal Technology can provide this improvement. Failure to meet this challenge will not only sacrifice environmental protection but will undermine national economic competitiveness leading to further erosion of industry and jobs.

The urgency of this joint commitment is underscored by the rapidly approaching challenge to the nation's electricity supply capability (Figure 1). Based on recent experience, we can expect electricity demand to continue to track economic growth. Satisfying even modest growth during the remainder of the century will require a balanced strategy involving additional improvements in conservation and end use management, greater productivity from existing generation capacity (reliability, heat rate and life extension), plus new generation capacity (Figure 2).

New Clean Coal Technology now under development could reduce the cost of this necessary capacity expansion by more than 50% relative to current experience. The industry's present, temporary, capacity margin provides a valuable window of opportunity for technical transition at minimal risk. The new clean coal technologies can now be introduced through incremental, small scale additions, repowering of existing units, "off-balance sheet" plants, and PURPA cogeneration opportunities. The rate of capacity expansion for the late-1990s and beyond cannot, however, be achieved without advancing the technology to much larger scale additions. It is therefore essential that this present opportunity be used to gain the experience and confidence necessary to meet the future capacity expansion challenge and to reduce the cost of electricity as the primary power source for our nation's economy (Figure 3).

In order to reduce the disadvantages facing conventional coal-fired power plants, Clean Coal Technology development in the United States has pursued two primary objectives; viz., to

A. Provide an array of retrofittable emission control options which satisfy, at reduced cost, the void between present physical coal cleaning capabilities and flue gas scrubbing for existing power plants.

B. Provide improved coal utilization alternatives for both repowering and new plant applications. These combine high levels of emission and effluent control with reduced costs and improved thermal efficiency.

As indicated by Figure 4, these objectives are geared to national, not just regional technology requirements. However, an important distinction should be recognized between these two objectives and the technologies they represent. The second has the potential to reduce the absolute cost and increase the productivity of power generation. The first objective can only limit the cost increase which would otherwise be imposed by more expensive retrofit controls.

Under objective A, the inefficiencies and costs of current flue gas desulfurization technology coupled with the uncertain possibility that existing plants may require retrofitting of emission controls leads to the need for additional, simplified emission control options. These range from improved physical coal cleaning to combustion modification, furnace sorbent injection, partial and dry scrubbing, and low $NO_x$ combustion. No single one of these options will satisfy the widely varying conditions in the range of existing coal-fired utility and industrial power plants. As a group, however, they can reduce the cost and productivity limitations of emission control today. Depending on regulatory requirements, the United States market for such retrofittable emission control options could be as much as 170,000 MW during the 1990s alone.

Selection will depend on a number of variables including control requirements, cost and functional criteria such as plant design and space limitations. Functional criteria can be a particularly important constraint when considering retrofit to existing plants. Unlike new plants where the boiler and emission controls can be designed as an integrated unit, retrofit requires adaptation to a plant not designed for such modification. Nevertheless, they can become particularly valuable in the event emission control on existing high sulfur coal plants is required. The potential for 50-70% $SO_2$ reduction is attractive under these circumstances.

EPRI has examined a variety of emission reduction requirements in terms of the potential savings achievable through optimal use of this array of new retrofittable technologies. In each case, capital and annualized costs were reduced from 25% to 40%. Unfortunately, the legislative and regulatory proposals developed thus far in the United States fail to provide the flexibility necessary to fully implement these opportunities, thus effectively limiting utilities to either scrubbing or retiring the majority of their units. A requirement to apply current flue gas scrubbing technology to existing units would impose an additional cost of nearly $300/kW and would force many units into retirement at a time when their power generation capability will be increasingly important to the reliable supply and cost of electricity.

Objective B, the use of new coal utilization technologies such as atmospheric fluidized bed combustion (AFBC), pressurized fluidized bed combustion (PFBC), and integrated gasification combined cycle (IGCC) has the potential to be more effective both in terms of environmental control capability and cost. These technologies combine emission control within the combustion or conversion process, rather than adding new process complexity. The result is both greater emission control efficiency and improved generation productivity to fundamentally resolve perceived conflicts between energy and the environment. As a result, they are a more effective use of national resources than additions of flue gas desulfurization systems to existing coal-fired capacity. This underscores the value of economic and regulatory incentives that emphasize prompt transition to these improved coal utilization options rather than diverting resources into "band-aid" retrofit efforts.

The key question which must be resolved before large scale application of these options can occur is proof of their long-term reliability under utility operating conditions. The EPRI program, therefore, stresses the development and demonstration of these options at sufficiently large scale to verify their commercial reliability. In the absence of broad government participation in these large, capital intensive projects, the burden of support falls today on the private sector.

The highly successful Cool-Water IGCC, and the three AFBC demonstration projects being led by the utility industry and EPRI provide effective models for these technology demonstration efforts necessary to accelerate Clean Coal Technology. EPRI has been pleased to be a partner and catalyst for these projects and looks forward to continuing its cooperative efforts, where possible, to stimulate the prompt acceptance of improved technology. Unfortunately, EPRI is able to fund less than half the scope of its planned program at a time when needs are increasing dramatically as a result of the industry's successful development efforts.

The strategic environmental advantages of the new clean coal technologies relative to conventional wet scrubbing are also substantial. Proposed acid rain control legislation -- that would retrofit flue gas scrubbers on up to 100,000 MW of existing, high sulfur coal-fired generating capacity -- could cost the nation as much as $12 billion per year over the remaining life of the affected plants. A more effective alternative would be to accelerate new clean coal technologies that offer greater emission control efficiency and improved generation productivity.

Figure 5 indicates the impact on $SO_2$ emission trends of various control strategies. Encouraging the application of advanced Clean Coal Technology such as fluidized bed combustion and gasification combined cycles for new plant and repowering applications achieves and, most importantly, sustains an increased downward trend in emissions while improving productivity. Proposed control strategies that focus on existing sources produce results which by comparison, rapidly diminish over time. If, for example, the $200 billion necessary to implement the scrubber retrofit strategy over the remaining life of the affected plants were instead invested on new plants using advanced clean coal technologies, it would provide about half of the new generating capacity the nation is likely to require during the next 30 years. Such an investment would provide superior environmental control, not only for sulfur oxides but also for nitrogen oxides and solid waste, while improving the productivity and cost of power generation.

Unfortunately, the legislative proposals for acid rain do not typically emphasize Clean Coal Technology; and as a result are likely to delay the use of these new technologies by forcing the industry to divert needed capital into retrofitting wet flue gas scrubbers as the only option which confidently retrofitted by the legislative deadlines. In the absence of an aggressive Clean Coal Technology demonstration program, conventional wet scrubbing remains the only control option available for most existing plants to meet the proposed emission reduction requirements. Any new regulatory requirements, if and when justified, should therefore emphasize flexibility and cost effectiveness if the more effective clean coal options are to be encouraged.

The restrictive requirements proposed to date are also likely to force, on economic grounds, the premature retirement of valuable generating capacity, particularly in the high sulfur coal using states. This will exacerbate the electric generation supply shortage expected in the later 1990s. The likely result will be a decrease in the quantity and reliability of electrical service. This would be coupled with a rise in electricity cost, likely forcing industry to relocate away from the affected regions to remain competitive.

## Clean Coal Technology Status and Demonstration Requirements

Figure 6 indicates the general cost and performance envelope for Clean Coal Technology in terms of (a) commercially available options, specifically flue gas desulfurization and physical coal cleaning; (b) advanced, retrofittable technology now entering the demonstration phase; and (c) advanced clean powerplant technology such as fluidized bed combustion and coal gasification-combined cycles for both new and repowered plant applications.

Figure 7 indicates the characteristic learning curve associated with the development and commercial deployment of new technology. Today, the various advanced Clean Coal Technology options under consideration are reasonably well developed and approaching first commercial service or demonstration. It is their "commercial demonstration" phase where the size and cost of the facility necessary to assure realistic operation is the greatest. This "conventional risk cost" then reduces over a series of additional installations until full commercial status is reached. It is recognition of this risk and the need to share in the cost of its resolution which defines the need for the National Clean Coal Technology Demonstration initiative.

The history of lime/limestone flue gas desulfurization (FGD) scrubbing technology in the United States provides a valuable but very expensive lesson on the price of exchanging "technology forcing" legislation and regulation for a cooperative development and deployment effort.

Contrary to sound development practice, FGD scrubber technology bypassed the scale-up process of development and was prematurely deployed at commercial scale as a result of legislative and regulatory requirements. The deployment process occurred in an adversarial atmosphere where the incentive was on least first-cost without adequate understanding of, or insurance against, the performance and reliability risks involved. As a result, this "brute force" approach to development and deployment has involved over 50,000 MW of electric generating capacity at a total cost to the utility industry and rate payer of over $20 billion (1987 $) in capital, operating and lost generating capacity costs during the past 15 years. Only now is the technology approaching acceptable reliability, although at an excessive cost in operational risk protection and redundancy which still requires substantial development attention.

Had FGD scrubber technology been developed and deployed in a more rational and cooperative manner, the cost could have been reduced to $1 billion-$2 billion involving no more than 2000 MW of capacity, with no delay in the time frame necessary to achieve maturity. In addition, the legacy of poorly performing or obsolete commercial scrubber installations and the resulting ill-will on the part of the user could have been avoided. One need look no further than the Japanese experience with FGD scrubbing technology to see the contrasting success and cost effectiveness of the more rational, cooperative approach to risk shared development and deployment.

Table 1 organizes the various advanced clean coal technologies into six general categories and summarizes their major risk factors which must be resolved through the demonstration process. The attached discussion describes the status and demonstration requirements for each of these general categories and their technology subsets (Attachment 1).

The response to DOE's November 1986 Phase II Request for Statements of Interest concerning Clean Coal Technology demonstration projects again affirmed these technical opportunities and the private sector commitment to their success. 137 expressions of interest were provided with potential, private sector, cost sharing exceeding $2 billion. This compares quite favorably with the 175 projects originally identified in February 1985, in response to the Phase I DOE Clean Coal Demonstration solicitation.

Table 2 categorizes these 137 submissions by technology. The number of retrofittable flue gas cleanup and coal preparation demonstrations is particularly noteworthy since neither of these categories was well represented in the projects selected by DOE during Phase I of the Clean Coal Demonstration Initiative.

Subsequent to the issuance of the Lewis/Davis Report recommendations, EPRI has completed an analysis of what might be a logical deployment plan for clean coal technologies. This analysis focused on the need to reduce the risk of clean coal technologies by deploying the options in sufficient numbers to provide a mature set of technologies. The analysis also identified and differentiated the risks specific to each technology. The results indicate that about 70 installations of 11 generic clean coal technologies, totaling about 14,000 MW, are required to provide sufficient information on the characteristics of the technologies for the market to view the technologies as being commercially viable. We believe that this deployment approach is consistent with the $2.5 billion risk-sharing plan proposed by the Lewis/Davis Report. The response to DOE's November 1986 Phase II Request for Statements of Interest concerning Clean Coal Technology demonstration projects affirmed these technical opportunities and the private sector commitment to their success. While EPRI will continue to provide technical assistance to, and work with, DOE as appropriate, we believe that a deployment strategy should focus on maximizing the opportunity for the marketplace to commercialize the most effective technologies.

The nation's ability to realize the opportunities that clean coal technologies provide will depend on the implementation policies used by the Administration and Congress. Based on the limited results of the Phase I Clean Coal Technology Demonstration initiative, the following modifications are recommended:

- The philosophy of project selection should better reflect DOE's role as an expeditor of technology for use by the private sector. DOE will not be the user or purchaser of the commercial products resulting from this program. Selection and procurement procedures should better reflect this distinction.

- The information requirements of the PON should be substantially reduced. The previous requirement for full-scale environmental analysis should be dropped in favor of a site-specific analysis of environmental impacts. More latitude should also be given to proposers in estimating potential for commercial use. The fact that a project is proposed shows that interest exists not only by the utility but its cosponsors who are typically the ultimate vendors.

- Ambiguity concerning repayment of Federal assistance should be eliminated. In the past, this has discouraged participation since utility profits are established by regulatory bodies that do not typically recognize risk sharing for new technology. It is important that future solicitation encourage stronger utility industry participation since this industry is by far the nation's largest user of coal and is fundamental to the nation's economy. It is also the industry through which the greatest environmental and productivity benefits can be realized by application of clean coal technologies.

- The federal government should take advantage of its unique opportunity to work more closely with the private sector in resolving the various constraints, often resulting from governmental action, on the use of innovative technology. In this context, cofunding is only one way in which DOE can help. DOE should also encourage, when opportunities arise, programs which could result in increased private sector R&D efforts and reduce the need for direct DOE involvement. For example, the state of Ohio has recently taken the initiative of funding Clean Coal Technology demonstration programs in such a way that the industrial partners retain the commercial and managerial incentives. The state role is to promote demonstrations by sharing part of the cost and insuring a reasonable rate of return on the remainder by acceptance in the utility rate base. Taken a step further, this federal encouragement of favorable state action becomes even more important to the prompt commercial deployment of Clean Coal Technology by the regulated electric utility industry. Particularly important are expedited permitting reviews, presumption of prudence, and prompt cost recovery.

- This underscores the need for an effective coordination mechanism between federal and state governments to develop cost and risk-sharing incentives in as effective manner as possible, including assured cofunding for multi-year demonstration and deployment programs. The establishment of this coordination mechanism, for example, could be encouraged by a conference of governors from coal utilizing and coal producing states along with the heads of affected federal agencies. An industry task force also needs to be established that is empowered to provide combined business and technical judgment, guidance, and direction for the federal Clean Coal Technology program. Such a panel could provide valuable input to the DOE and Congress in the prioritization and acceleration of Clean Coal Technology having important commercial and environmental potential.

# Part II

# STATUS OF THE ACID DEPOSITION ISSUE

## II. STATUS OF THE ACID DEPOSITION ISSUE

National and international environmental interest in the acid deposition phenomenon has spawned intense research programs by EPRI and federal and state governments that involve researchers at many universities, national laboratories, and private sector organizations. This research effort has greatly increased knowledge of the acid deposition phenomenon during the last five years. However, many uncertainties still exist. No legislation has been adopted in the United States, not only because of continuing uncertainties, but also because science has shown in many instances that early claims of catastrophic, irreversible effects were overstated. Several states and Canada have passed their own emissions control legislation aimed at reducing acid deposition.

Canada and the United States appointed special envoys in March 1985 to consider the acid deposition issue. The resulting report has recommended a 5-year, $5 billion technology R&D program, funded jointly by the U.S. government and U.S. industry.(1) Also, the report recommends additional research on six scientific issues. No specific recommendations were proposed for emissions reductions.

Nationally, man-made sources of sulfur compounds -- largely electric utilities (about 2/3 of the total), industrial combustion, and smelters -- account for an estimated 24.6 million metric tons of $SO_2$ emitted annually (1980 emissions inventory).(2) Man-made sources of nitrogen oxides -- largely motor vehicles and electric utilities (about 1/3 each) -- emit an estimated 21.5 million metric tons $NO_x$ annually.(2) Natural sulfur emissions are roughly 3% of the man-made emissions in eastern North America.(2,3) Natural sources contribute less than 10% of $NO_x$ emissions in eastern North America.(4)

Nationally, $SO_2$ emissions increased about 50% from 1940 until the early 1970's, but declined by about 25% thereafter through 1980.(2,5) A further reduction of 10% has been observed in the 1980's.(6) These declines are attributed to an increased use of low-sulfur coal and flue gas desulfurization, since total annual coal use has increased 70% over the same time period. Nitrogen oxide emissions tripled from 1940 to the early 1970's, declined by about 5% during the 1970's, and have been approximately stable during the 1980's.(5,6)

Two key questions are the focus of research at both EPRI and the federal government's National Acid Precipitation Assessment Program (NAPAP).

1. What are the environmental consequences of acid deposition and rain acidity?

2. What are the atmospheric transport and transformation processes that relate emissions sources to deposition in the geographic areas of ecological concern?

## DEPOSITION MONITORING

Current patterns of acid deposition are well documented, although temporal trends in deposition remain difficult to detect. Extensive precipitation chemistry networks have been established across the United States and Canada, including the EPRI-run UAPSP network of 20 wet deposition stations in the eastern United States. However, until recently, regional trends in the acidity of precipitation could not be detected, due to the variability of the data and the lack of an adequate long-term record. Analyses of data collected over the last seven years indicate no significant regional changes (increases or decreases) in acidity.(7) Eastern North America receives the highest concentration of acid in precipitation on the continent. About 2/3 of the acidity in eastern precipitation can be associated with the sulfate ions, while in urban areas in the West, nitrates appear to play a more dominant role (up to 1/2 of the acidity in precipitation).(2)

Dry deposition also contributes to the total atmospheric input of acidic substances, but its contribution relative to wet deposition remains largely unknown. NAPAP is developing a national monitoring program for dry deposition with improved measurement techniques to reduce the large uncertainties (greater than a factor of two) in the dry component of acid deposition.(2)

## ATMOSPHERIC PROCESSES

The relative contribution of specific sources to deposition in sensitive regions is uncertain. A principal uncertainty in developing effective control action is the present inability to describe quantitatively the source-to-receptor relationship. When averaged over annual time periods and large areas, the relationship between changes in regional sulfur dioxide emissions and regional sulfate deposition appears linear, but this relationship does not seem to hold true for smaller spatial or time scales.(8) Research at both EPRI and in NAPAP is focusing on the complex atmospheric transport and transformation processes that determine pollutant deposition. Modeling efforts are attempting to understand better where controls could be best implemented to achieve the most cost-effective deposition reductions in ecologically sensitive areas. More specifically, the broad-based Regional Air Quality Studies (RAQS) at EPRI were initiated in order to develop predictive tools to relate emissions to resultant air quality.(9)

Both empirical evidence and advanced model development are beginning to identify specific source to receptor relationships. However, the empirical evidence contains large uncertainties, and the advanced models have not been subjected to critical evaluation against "real world" measurements.(9)

Several research programs by EPRI and national agencies conducted over the last decade have provided empirical evidence that the "zone of influence" of acid deposition's precursor emissions ($SO_2$ and $NO_x$) is less than about 500 km in eastern North America.(10) However, the EPRI and EPA feasibility studies for long range tracer experiments have noted that these empirical results are subject to large error, primarily because of uncertainty with regard to chemical conversion rates and dry deposition estimates.(11)

Because of the continuing uncertainty in an empirical approach to resolving source-receptor relationships (i.e. lack of a suitable chemically reactive tracer) current research is directed more toward scientific improvement of the air quality models and the acquisition of data needed to evaluate these models. EPRI's research program in this area is stressing atmospheric transport processes and in-cloud chemistry, as is the NAPAP/DOE project "PRECP".(2) Other NAPAP efforts are directed toward acquiring an improved understanding of dry deposition. EPRI is cooperating with both the US/NAPAP and Canadian agencies in the development of two advanced regional air quality models. Also, the parties are developing and implementing the large field efforts required to validate these models from an operational and scientific reliability point-of-view. An 80- to 100-station network, designed to measure atmospheric concentrations and deposition of acidic materials is scheduled to begin operation in 1987.(2) These data are required to establish the reliability of model calculations of monthly, seasonal and annual deposition of acidic materials -- the operational use of the models. Various specialized scientific measurement projects are being reviewed for their input to the scientific, or diagnostic, evaluation and improvement of these models.

There is increasingly strong evidence that wet sulfate deposition in the eastern U.S. is a non-linear function of $SO_2$ emissions and associated oxidant formation. (The relationship between $SO_2$ emissions and deposition is linear over large spatial and temporal scales (thousands of miles, and years).) Empirical associations between $SO_2$ emission densities and observed wet sulfate deposition, both averaged over an annual cycle, tend to substantiate a linear relationship in the very low $SO_2$ emissions areas in the western U.S., but show a highly non-linear association in subregions of the eastern U.S. where emission densities are 10 to 100 times greater than in the West.(12)

The substantiation and quantification of the transport and chemical transformation of precursor sulfur and nitrogen oxide emissions to their acidic form is one of the focal points of much of the EPRI research. Since these are complex, multivariate systems, the quantification processes in the regional models will be followed by analyses to understand how emission control strategies for oxidant precursors, as well as for sulfur and nitrogen oxides, affect deposition in sensitive areas. For example, the non-linear association between $SO_2$ emissions and wet

$SO_4$ formation requires 50 to 100% more unilateral $SO_2$ reductions than is required by a linear association.(13) Reduction of airborne concentrations of the $NO_x$ and hydrocarbon precursors responsible for oxidant formation may reduce wet $SO_4$ formation proportionately.(13) Analyses to optimize emission control strategies must be based on reliable simulation models.

## TERRESTRIAL EFFECTS

The relationship between acid deposition and observations of forest decline in central Europe and the Eastern United States is not known. Recent observations of forest declines in Europe and the United States have prompted researchers to investigate acid deposition as a potential contributing factor to the decline.(14,15) Pollution in general, and ozone in particular, are suspected to be important contributors to forest tree damage, but, at present, no conclusive evidence exists that acid deposition is a casual factor in the forest decline phenomena.(14,15)

Forest decline is occurring to red spruce at some high elevation sites in the Northeast, but not at low elevation sites or in the Southeast.(14) The cause of the decline is not known. Acidic deposition is one hypothesis, but several others (pathogens, climate stress) are as strong or stronger hypotheses undergoing study. Isolated mountain peaks and ridges in the Southeast exhibit visually dramatic death and decline in Fraser fir (e.g. Mount Mitchell, NC). The balsam wooly aphid is a likely cause.(16) Young seedlings are naturally replenishing the stock and show no signs of aphid attack. A decline in productivity has been postulated for the Southeast pine species. The decline has not been rigidly documented, but is receiving further study by the USFS and forest industry.(17)

Ozone has recently become popular as another hypothesis for forest decline, because of its known damage to many crops and white pine at low concentrations.(18) However, only Ponderosa pine in southern California has field verification of damage and decline due to ozone. Ozone-tolerant oak and shrub species are replacing Ponderosa pine in much of the San Bernardino mountains. Ozone effects on trees in indoor chamber experiments have not been replicated to date under "real world" conditions. Research is expanding rapidly.

There are many confounding actions occurring in forests that will require further investigation before cause-and-effect relationships can be established. Considerable research on cause-and-effect relationships are underway. EPRI is conducting three major studies along these lines:

1. the Aluminum Biogeochemistry Study (ALBIOS);
2. the Integrated Forest Study (IFS); and
3. Response of Plants to Interacting Stresses (ROPIS).

Co-funding by individual electric power companies plays a prominent role in EPRI's research. NAPAP has started its own major research program and co-sponsors the Integrated Forest Study, and the forest industry is also funding work.(14) EPRI staff work closely with their counterparts in the government and the forest industry, and play major roles in NAPAP review and advisory committees. While these research efforts will produce significant increases in understanding over the next five years, it will most likely take a decade to approach complete resolution of the major scientific issues.

Research results indicate that crops are not likely to be significantly affected by acid deposition. Effects on agricultural crops from ozone at current concentrations in agricultural regions are well established.(19,20,21) On the other hand, effects from acid deposition on crops appear to be minimal at current levels. Studies on soybean, corn, wheat and many other crops have shown that most varieties are not sensitive, although results from crops studies in general are variable and many crops' cultivars have not been tested. EPRI has conducted a series of studies on selected crops in the Northeast, Midwest, Southeast and West. In general, agricultural management practices would be expected to overwhelm any impacts of acidic inputs on agricultural soils.(21)

Acid deposition does not affect managed soils. Unmanaged soils in forests and watersheds are being studied for possible effects of acid deposition. Cultivated (managed) soils are not expected to be adversely affected by acid deposition.(21) Many soils are probably well buffered against effects of acid deposition. Some soils are naturally acidic. Thus one cannot assume that acid deposition will cause widespread acidification of soils.(22) EPRI has incorporated soils studies into the research efforts on forests and watersheds. For example, under the study "Aluminum Biogeochemistry of Forested Watersheds" (ALBIOS), the relation between acid deposition and increased concentrations of aluminum in the soil is being investigated as it relates to forest effects. Several studies have cast doubt on aluminum mobilization as a general mechanism for explaining the effect of acid deposition on forest decline.(14)

## AQUATIC EFFECTS

The impacts of acid deposition on aquatic systems is largely determined by the soils, geology and vegetation of the surrounding watershed. Aquatic systems with limited acid neutralizing capacity are characterized as nutrient poor, surrounded by thin (or no) soils and underlaid by non-calcareous rock (such as granite). Sulfates, probably much more than nitrates, play an important role in the acidification of aquatic systems. In addition to the amount and acidity of deposition, the acidification rate of aquatic systems is controlled by the release of base cations to the water flowing through the soil to the system, the retention of sulfate by the surrounding watershed, and by the biological transformations within the terrestrial and aquatic systems. However, nitrate inputs, such as episodic, acidic events during spring snowmelt, may also produce detrimental shocks to aquatic systems.(23)

EPRI's Integrated Lake-Watershed Acidification Study (ILWAS) provided the first quantitative basis for assessing the relative importance of all factors, including natural phenomena, that govern watershed acidification.(24) The predictive model developed for this study is in wide use in North America.(25) Several utilities are employing ILWAS, as well as researchers in Western, Midwestern, and Eastern states, and Norway and Sweden.

Liming has been successfully used in Scandinavia and in North America to restore fisheries in acidified lakes. The addition of lime and other neutralizing substances has long been a tool in fisheries management.(26,27,28,29) When liming is used along with appropriate restocking and lake management practices it can lead to restoration of recreational fisheries. Studies in Sweden and North America, however, have emphasized primarily restoration of fisheries and not other possible ecological effects in the treated watersheds. EPRI's Lake Acidification Mitigation Project (LAMP) focuses on fundamental scientific issues associated with the response of sediment, water chemistry and biota (fish and other ecosystem populations) after addition of lime to lakes. Research in LAMP has shown that the rate of reacidification of a limed lake is mostly dependent on the lake's flushing rate and that in deep lakes, two sizes of lime particles are required. Both findings are important to the design of lake management practices. No adverse ecological effects of liming on lakes have been found.(30)

## HEALTH EFFECTS

Pathways for effects on human health have been suggested, but none has been established. The potential effects of acid deposition (as opposed to sulfate particles and aerosols) on human health would occur only indirectly, due to increased metals solubility (e.g., lead) and corrosivity in drinking water supplies, and bioaccumulations of metals along food chains (e.g., mercury and other metals in consumed fish). No adverse effects on human health causally related to acid deposition have been established. Moreover, techniques for managing such water supplies are available and are used where needed in all major water districts. The extent of human exposure appears small and the data are scarce. (31)

Acidic sulfate aerosols have received increasing attention in the scientific literature in the past two years, with suggestions that they may aggravate respiratory problems in asthmatics. The

Environmental Protection Agency is reviewing this matter to determine whether additional ambient standard protection is needed.(32)

## MATERIALS DEGRADATION

Acids can cause degradation of materials. However, there is significant uncertainty on the role of acid deposition and other pollutants in material degradation, relative to natural causes such as sunlight, moisture, and temperature changes. The most reliable data exist for certain metals; only preliminary data are available for other materials. Concern about accelerated damage to materials and cultural monuments originated in Europe, where centuries-old buildings and artwork have shown increased rates of decay, especially over the past one hundred years.(33) Air pollution, including acid deposition, is believed to be a primary cause, although mechanisms of damage are not well understood.(34) It is difficult to distinguish between the effects from natural and man-made factors.(35)

EPRI and NAPAP co-sponsored a review of available data on damage processes to determine what role, if any, air pollution plays.(36) Reliable data were found for estimating damage functions for the metals, with the best data available for galvanized steel (zinc).(37) Analyses of these data suggest that $SO_2$ and the $H^+$ ion (components of acid deposition) may be associated with accelerating the corrosion of zinc. There is, however, considerable uncertainty inherent in the estimated damage relationship. For other metals, greater uncertainty is present. For non-metals, insufficient data are available to attempt to estimate quantitative relationships between damage and $SO_2$ and the $H^+$ ion.

A better understanding of damage processes and related environmental factors is necessary to develop credible economic estimates. Existing estimates of materials damage lack economic validity because they fail to relate real consumer and maintenance behavior to physical damage.(38) Recent economic assessments assume, for example, that an individual automatically repaints his house when the thickness of a paint coating decreases beyond some critical level. Yet, the more common causes of paint failure are peeling, cracking and blistering.(39) These modes of paint failure are not directly related to paint thickness, yet these modes may be more important in triggering consumer maintenance. The relationship between paint blistering, peeling, and cracking, and acid deposition is unknown, thus reliable estimates of economic damage can not be made.

EPRI has started an effort to compile a database on consumer behavior in response to materials damage (specifically, paint damage) that may be associated with acid deposition. Incorporation of this database into damage estimation procedures is essential for obtaining credible damage estimates in economic terms.

## COST/BENEFIT ANALYSES

The economic valuation of total environmental damage caused by acid deposition is uncertain and incomplete. Several economic studies have attempted to value the potential effects of acid deposition.(40) These studies attempt to estimate the damage caused by acid deposition under various emission control scenarios. The costs of the control scenarios can then be compared with the reduction in damage associated with them. The accuracy of these economic assessments depends on

1. how well the assumptions about physical damage and exposure reflect actual field conditions, and

2. how well the economic methodology reflects the behavior of individuals as they respond to changes in environmental quality and to physical (environmental) damage.

Since there are no economic market data available for many of the damage categories of concern, (e.g. forests, aquatic life, lakes), non-market methods must be used to evaluate damage. At present, there is considerable uncertainty associated with these methods.(41) For example, the most commonly used methods to estimate damage are contingent valuation and bidding game surveys, in which respondents are asked how much they would be willing to pay to achieve or avoid an environmental change. EPRI and EPA research have both shown that focusing upon one environmental good can easily lead to overestimation of damage.(42) Several other potential sources of bias exist with this method. These have been documented in EPRI and EPA reports.(43) Other damage estimation methods suffer from similar problems.

EPRI has a program underway to understand how the various sources of bias impact damage estimates and how and if the various biases can be overcome. Other facets of the research will also determine the capability of subjects to evaluate intangible goods in economic terms. Alternative evaluation approaches are also being explored.

Improved tools are being developed to assist decision makers in evaluating the options for addressing the acid deposition issue. Decisions concerning acid deposition are necessarily made under uncertainty. These decisions involve potentially very large risks. Acting now to reduce emissions carries the risk that large expenditures will be made with little or no beneficial effect, while waiting carries the risk that significant ecological damage will be incurred that could have been prevented by prompt action. The Acid Deposition (ADEPT) framework provides an analytical structure, based on a decision science approach, for bringing together and summarizing current information and uncertainties to determine the least-cost decision.(44) The model is particularly useful for analyzing issues such as

1. cost and benefits of SO2 and NOx emissions reductions,
2. costs and benefits of alternative mitigation strategies such as lake liming, and
3. choice of research strategy.

ADEPT, which was recently favorably reviewed in the Journal of the Air Pollution Control Association (45), has been licensed to over 30 utilities. The U.S. Department of Energy, Environmental Protection Agency, General Accounting Office, and Office of Technology Assessment are also licensed to use the model, as are the Central Electricity Generating Board, The European Economic Community, and the International Institute for Applied Systems Analysis.

EPRI's ADEPT model has, and is, being used by decision makers to gain new insights and analyze complex choices when addressing acid deposition issues.(46) Integrated assessment methods are also being produced in NAPAP to address the complex interaction of the many economic and environmental variables involved in acid deposition issues. The EPRI work on ADEPT is being coordinated with the national effort, in order to ensure that ADEPT is able to take advantage of the large amounts of data being generated.

# Part III

# SUMMARY AND CONCLUSIONS

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### CLEAN COAL TECHNOLOGY

1. The principle which guides clean coal technology development is that sustained environmental improvement can only be achieved when both emission and cost reduction are achieved concurrently, not pitted against each other. Clean Coal Technology thus provides a unique opportunity to concurrently satisfy two national goals: (a) continue the substantial progress made in emission control by resolving the conflicts between coal use and environmental protection and (b) meet the rapidly approaching electricity generating capacity challenge with reduced cost and increased productivity.

2. Demonstration efforts should be initiated promptly through joint industry/government sponsorship for improved repowering and new plant coal utilization methods, and for the array of cost effective, retrofittable emission control options. These are necessary to commercially realize the successful clean coal technology development efforts which have been under way for the past decade. The highly successful Cool Water integrated gasification combined cycle and the three atmospheric fluidized bed demonstration projects being led by the utility industry and EPRI provide effective models for these technology demonstration efforts necessary to accelerate clean coal technology.

3. The Phase I Clean Coal Technology Demonstration projects awarded by DOE in July 1986 will not be sufficient to meet the objectives of the Congressional Clean Coal Technology Initiative. Ample opportunities to satisfy these objectives have been identified, however, in the subsequent 137 responses to DOE's November 1986 Request for Statements of Interest concerning Clean Coal Technology Demonstrations.

4. The inflexibility of proposed legislation intended to further reduce emissions tends to discourage the application of innovative clean coal technology and limit freedom of choice. The result may be to substantially increase the cost of compliance and delay implementation of new clean coal generating capacity which combines emission control and cost reduction. The result will be eroded environmental quality and economic productivity, quite contrary to the expectations of the legislation.

5. The future for clean coal technology is now. Success depends on prompt, aggressive action by government and industry to both accelerate demonstration and remove impediments to prompt commercial application. EPRI is prepared to continue to do its part in supporting these efforts.

6. We subscribe to the idea of the deployment of Clean Coal Technology being a market-driven process, initially cofunded to reduce technological risks to a level acceptable to the early adopters, and their investors. The demonstrations of the technologies will lessen the technological risks and add to the market's understanding of the technologies, bringing them to the point of commercialization where the market, eventually unaided by cofunding, will be willing to invest independently in proven clean coal technologies.

7. The establishment of a Clean Coal Technology deployment program will better enable the private sector to assume those technological and financial risks that are an essential element of the commercialization process. This program should provide the coordinated development and application of regulatory, financial and other incentives to facilitate the prompt, widespread commercial application of these technologies.

## ACID DEPOSITION

Environmental effects:

8. Research efforts to date have added significantly to our understanding of the lake acidification process and methods to mitigate adverse effects.

9. Likewise crops show no evidence of significant adverse reaction to acid deposition in studies to date. Forest decline represents a more recent concern and is the subject of intense study at the present time.

10. Research efforts over the last decade have improved our understanding of the transport and coversion of sulfer and nitrogen emissions. However, we are not yet able to relate changes in deposition in the sensitive regions of the continent to source regions.

11. Continued emission reduction through demonstration and commercial deployment of Clean Coal Technology should provide the margin of confidence desired by environmentalists in protecting our national resources without compromising the productivity of our economy or power plants and with minimum likelihood of creating still other environmental concerns.

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## Appendix 1

## CLEAN COAL TECHNOLOGY OPTIONS

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## CLEAN COAL TECHNOLOGY OPTIONS

### 1. COAL CLEANING AND UPGRADING

### a. Advanced Physical Coal Cleaning

Description: Advanced physical coal cleaning involves four basic operations: (1) fine crushing of all coal cleaned to achieve high pyritic sulfur and ash liberation; (2) use of advanced physical cleaning processes such as microbubble flotation, selective flocculation, true heavy liquid separation, or some combination; (3) use of advanced fine coal physical dewatering technology; and, (4) clean coal agglomeration to produce a handleable product. Advanced physical coal cleaning technology could be combined with conventional cleaning technology in ways that result in cleaning plants that produce multiple fuels of different quality, such as low-sulfur coal for conventional firing and a high-sulfur coal for fluidized bed combustion firing. This technology has the potential to double coal pyritic sulfur removal over currently available cleaning methods from approximately 40% to 80% removal. The estimated ultimate cost of this technology is \$400-600/ton of $SO_2$ removed including credits associated with utility firing of improved quality coal.

Status:. An EPRI survey identified 25 developmental, physical fine coal cleaning processes. The most promising processes are being evaluated at 1 ton/hour scale under a joint DOE-EPRI project at the EPRI Coal Cleaning Test Facility. This testing program, which is scheduled to run through 1989, will provide the basis for demonstration plant design. EPRI, Ohio Edison, and the Ohio Coal Development Office are evaluating multi-product coal cleaning at a scale of 20 tons/hour. EPRI, DOE, and the Alberta Research Council are developing a desulfurization process based on oil agglomeration. The Central Electricity Generating Board (UK) is developing a dry magnetic coal cleaning process. Several private U.S. companies are developing processes at bench-scale.

Demonstration Requirements: Major developmental issues are process performance, a viable clean coal agglomeration process, and economics. To be considered commercial technology for major U.S. coal types, 5-7 demonstration plants would be required with clean coal capacities on the order of 150 tons/hour. These demonstration plants would involve different advanced physical coal cleaning, dewatering, and agglomeration technologies and different combinations of these technologies with conventional cleaning technology. The estimated cost of a typical demonstration project (3-5 year duration) is $40-60 million.

b. Low-Rank Coal Upgrading

Description: Low-rank coal upgrading processes produce a high-Btu, low-sulfur, low-moisture, low-ash fuel by thermally removing moisture and, in some processes, sulfur and/or ash from subbituminous coal or lignite. To produce a product with handleability and storability comparable to high quality bituminous coal, coal particle surfaces are altered during upgrading, or subsequent to it, to reduce moisture re-absorption. These processes can potentially produce compliance coal (less than 1.2 lbs $SO_2$/MBtu) from many western coals and lignite. Estimated upgraded coal cost is $30-40/ton, f.o.b. plant.

Status: Western Energy, Amax Coal, K-Fuel, ARCO, Mobil, Bechtel, the University of North Dakota Energy Research Center, and others are developing upgrading processes. Western Energy is operating a 200 lb/hour pilot plant and has proposed to build a demonstration plant under the Federal Clean Coal Program. K-Fuel is operating a 500 lb/hour pilot plant and is planning a 100 ton/hour demonstration plant in the Powder River Basin. Several major western coal producers have announced plans for coal or lignite upgrading projects.

Demonstration Requirements: Major development issues are ultimate product quality and economics. To determine which of the competing technologies are commercially viable and account for coal and lignite processing differences, 3-5 demonstration plants with upgraded capacities on the order of 150 tons/hour would be required. The estimated cost of a typical low rank coal upgrading demonstration project (3-5 year duration) is $40-50 million.

2. WET FGD

a. Advanced Conventional FGD

Description: Improvements in conventional FGD can be illustrated using three examples. First, process improvements such as the jet bubbling reactor used in the Bechtel CT-121 Process; second, application of spray drying to high sulfur coal; and third, an advanced, conventional limestone FGD system producing gypsum with no reheat and no redundant modules for use at compact sites. Each of these designs can achieve 90 to 95% $SO_2$ control. The cost and performance advantages are a 20-50% capital cost savings and 20-40% operating cost savings over conventional FGD systems available today. The jet bubbling reactor and advanced limestone/gypsum designs can both make wallboard grade gypsum for sale or disposal. Capital costs for such systems will vary depending on a number of factors such as fuel sulfur content and unit size. Typical retrofit cost for a 200 MW unit burning medium to high sulfur coal (2.5% to 4%) is about $200-$300/kW.

Status: Several advanced conventional FGD processes are being or have been tested at large pilot and commercial scale. The CT-121 process has been piloted on high sulfur coal at 23 MW by EPRI and is operating in Japan on 3% sulfur coal at 250 MW. A 40 MW industrial unit will be tested in 1987 by EPRI and the State of Illinois. Bechtel is attempting to sell a commercial utility unit; EPRI would test the unit's performance which is planned to occur in 1989-1990.

The high sulfur coal spray drying designs adapt the successful concept currently used on 7000 MW of low sulfur coal capacity. Two pilot plants are currently starting operation to test performance on high sulfur coal. TVA, Ontario Hydro, and EPRI are testing a 10 MW spray dryer/ESP combination at Shawnee, and EPRI is testing a 4 MW spray dryer fabric filter at the High Sulfur Test Center near Buffalo. Testing should be complete in 1989. A full-scale 160 MW demonstration of a high sulfur spray dryer/fabric filter has been proposed by TVA for funding under Phase II of the Clean Coal Technology program with testing to be completed in 1991.

Advanced conventional FGD systems using limestone and producing a salable gypsum byproduct with no spare modules, no stack gas reheat and gypsum byproduct sales have not been demonstrated at pilot or full scale in the U.S. EPRI will pilot test these improvements at the High Sulfur Test Center at 4 MW. New York State Electric and Gas has proposed testing this system at 168 MW as part of the Phase II Clean Coal Technology program concluding in 1989-1990.

Demonstration Requirements: Issues requiring resolution include: finding suitable commercial sites for demonstrations of advanced processes such as CT-121 and providing risk cost sharing for the work; establishing the performance and cost associated with high sulfur spray drying; and establishing the reliability and performance of a simplified advanced limestone FGD system producing gypsum. For these example systems, the number of demonstrations desirable to reach commercial acceptance include two jet bubbling reactor systems - one using a prescrubber and one without; two high sulfur spray drying demonstrations, one with an ESP and one with a fabric filter; and two advanced limestone systems with different absorber oxidation tank arrangements. Each demonstration should be at least 100 MW in size using at least 3% sulfur content coal. Total costs for these demonstrations is approximately $140 million.

b. Advanced Regenerable FGD

Description: Advanced regenerable FGD systems can use diverse physical and chemical principals, but generally recover sulfur byproducts as concentrated $SO_2$, sulfuric acid, or elemental sulfur. Three $SO_2$ or $SO_x/NO_x$ processes illustrate the development status of advanced regenerable FGD processes. One process combines a conventional sodium based scrubber with electrolytic regeneration of the scrubbing solution using a bipolar membrane (e.g., SOXAL). Another process uses dry activated carbon (char) pellets to adsorb $SO_2$, with $NH_3$ injection to remove limited amounts of $NO_x$ (e.g., Mitsui). A third process removes $SO_2$ and $NO_x$ by chemisorption in a surface layer of sodium carbonate deposited on a gamma-alumina substrate (e.g., NOXSO). The sodium scrubbing process can remove over 95% of the $SO_2$ but no $NO_x$. The activated carbon process can remove over 95% of the $SO_2$ and 40%-60% of the $NO_x$. The chemisorption process can remove about 90% $SO_2$ and 90% $NO_x$. The processes are more capital intensive than throw-away FGD (approximately $300-400/kW for regenerable systems versus $200-300/kW for a comparable gypsum system), but are projected to be competitive in levelized cost (approximately $600/ton $SO_2$ removed). The major advantage is in elimination of waste disposal costs.

Status: The advanced regenerable FGD processes are currently at small pilot scale with the exception of activated carbon process which has a 100 MW prototype operating on low sulfur coal in Japan. The sodium scrubbing process is being tested at small pilot scale (0.4 MW in Canada) and will soon be tested at 0.4 MW at EPRI's High Sulfur Test Center. A full-scale test has been proposed at an Illinois power plant in response to the Phase II Clean Coal Technology program. The chemisorption process has undergone pilot development in Japan, and is operating at the Omuta station of Mitsui Aluminum on a 100 MW base load coal-fired boiler. The process has been tested on a 50 acfm slip stream at TVA's Shawnee station and, more recently, at 1 MWe equivalent at DOE's PETC facilities. Additional tests are planned at this scale through 1987.

Demonstration Requirements: All of these systems require full-scale prototype testing on U.S. coals to verify system performance and costs and establish that they are competitive with conventional FGD. The issues regarding sodium scrubbing are whether the membranes can tolerate small amounts of flyash contamination, and whether optimized system operation will result in competitive economics. The activated carbon process issues include sorbent attrition and controlling dust emissions from the char. The chemisorption process issues include sorbent attrition, materials choice, and reducing gas use for regeneration.

The demonstrations required to ready these processes for the commercial market include: 2 sodium scrubbing process demos - one producing liquid $SO_2$ and one using off-peak power for regeneration; one activated carbon process demo on high sulfur U.S. coal; and two chemisorption process demonstrations, one aimed at moderate (50%) $NO_x$ removal and one aimed at 90% $NO_x$ removal. Each demonstration should be at least 100 MW in size using at least 3% sulfur content coal. Total costs for these demonstrations would be approximately $180 million.

## 3. DRY $SO_2$ CONTROL

### a. Furnace Sorbent Injection

Description: Furnace sorbent injection (FSI) refers to the injection of calcium-based sorbents (lime or limestone) into the radiant zone of the furnace where it calcines and then reacts to form $CaSO_4$ in the 2300-1600°F temperature range. The sulfated sorbent is then collected along with the fly ash in the precipitator or baghouse. An alternate process, convective pass injection (CPI), is a similar process in which the sorbent is injected near the economizer at approximately 1000°F.

$SO_2$ removal for FSI is a function of sorbent choice and quantity injected but is typically 35-45% with limestone and 50-60% with lime at injection rates corresponding to calcium to sulfur ratios of two. The process is characterized by low capital costs (approximately $50/kW), simplicity of design and operation, and costs which are about $200 - $500/ton of $SO_2$ removed lower than those typical of wet FGD. CPI performance and costs are presently comparable to those for FSI. The lower temperatures at the injection location and the extremely fast reaction rates hold promise of performance improvements using enhancement techniques which are inapplicable at FSI temperatures.

Status: FSI is being demonstrated at full-scale at two U.S. power plants: (1) Ohio Edison's Edgewater Plant by USEPA, USDOE, the State of Ohio, and others; and (2) Richmond Power and Light's Whitewater Valley station by EPRI and USEPA following extensive pilot scale development by EPRI and EPA. Several smaller scale industrial demonstrations in the US and utility demonstrations in Canada and Western Europe have been successfully completed.

CPI is still in the bench and pilot-scale development stage, although limited full-scale tests of an unoptimized system at Saskatchewan Power's Boundary Dam plant suggest that pilot results can be achieved in practice.

Demonstration Requirements: Although FSI is furthest developed of the several dry $SO_2$ control technologies, full-scale demonstration is needed to resolve potentially adverse impacts on plant operations. These include fouling of convective pass heat transfer surfaces in the furnace, excessive particulate emissions, and solid waste management and disposal problems resulting from increased by-product quantities and the high reactivity of the unreacted sorbent. In addition, methods must be explored to reduce sorbent use and costs through sorbent recycle, downstream humidification, or supplemental duct injection to extend the range of units for which the technology would be economical.

Two or three additional demonstrations beyond those two currently underway should include application to a cyclone unit with high flue gas quench rates and application of sorbent injection in combination with reburning for $NO_x$ control. Two such demonstrations are planned as part of the DOE Phase I Clean Coal Technology program to be conducted in Illinois with support of the state of Illinois, the Gas Research Institute, and the city of Springfield. Additional projects were proposed in the DOE Phase II solicitation including a comprehensive cyclone demonstration in Wisconsin. The demonstrations should be complete by early 1990 at a cost of approximately $30 million.

### b. Duct Sorbent Injection

Description: Duct sorbent injection refers to those processes where the sorbent is injected into low temperature flue gas downstream of the air preheater. $SO_2$ removal can be accomplished with either sodium- or calcium-based sorbents. In the case of calcium-based sorbents, it is necessary to humidify the flue gas to within 40-20°F of the saturation temperature in order to achieve sufficiently high reaction rates for economical $SO_2$ capture. This can be accomplished either through separate humidification followed by dry sorbent injection or through slurry injection in the case of in-duct spray drying.

As with furnace sorbent injection, these processes are characterized by moderate sulfur capture (40 to 70% $SO_2$ removal), simplicity of design and operation, low capital cost and attendant savings in levelized removal costs. Several varieties of the basic technology are possible including in-duct spray drying using a slurry, dry duct injection using sodium or calcium sorbents, and a hybrid system which includes retrofit of a fabric filter after the existing ESP. In the latter, a dry calcium sodium sorbent is injected into the clean gas stream following the ESP. All have capital costs of about $50/kW with the exception of the hybrid system which is about $100/kW due to addition of the baghouse. However, the latter is potentially capable of about 70 percent $SO_2$ removal (versus about 40-50% for the others) resulting in a cost effectiveness of about \$600-650/ton of $SO_2$ removal making it an attractive alternative to other dry systems.

Status: Table A-1 summarizes the stage of development for each process, the important development projects currently underway in the US, and the important issues to be resolved prior to commercial availability. Each of the processes for which pilot-scale development is successful will require full-scale demonstration to resolve operating issues such as particulate control, waste management and disposal, and the severity of duct deposition, plugging, and corrosion.

Demonstration Requirements: As indicated in Table A-1, the dominant issue for all of the calcium-based processes is humidification and whether it can be achieved without unacceptable duct deposition or precipitator degradation. It is likely that as many as a dozen demonstrations will be required to cover the range of processes, coals, and particulate controls. Several of these demonstrations may be combined with FSI demos currently underway at Edgewater and Richmond. The demonstrations could be completed by 1992-3 at a cost of \$2 to \$4 million each.

## 4. $NO_x$ CONTROL

### a. Combustion Modification

Description: Combustion modification achieves $NO_x$ reductions through the redesign of burners or through rearrangement of the fuel and air flows to the furnace (such as overfire air or reburning) in order to control the mixing of the fuel and air in relationship to the local temperature patterns. Maintenance of fuel rich conditions in the primary flame zone followed by gradual air addition later in the combustion process minimizes $NO_x$ formation. Reburning involves the redirection of 10-20% of the total fuel to the mid-furnace region to create a zone for reduction of $NO_x$ formed in the primary burner zone. Such methods are applicable to oil and gas units as well as coal.

Achievable reductions are typically 40-60% although a combination of methods (low $NO_x$ burners followed by reburning, for example) may achieve 75-80% reduction over uncontrolled emissions in some cases. Capital costs for retrofit low $NO_x$ burners are estimated at \$5 to \$10/kW with no additional operating costs expected. Reburning costs depend on the choice of reburning fuel (gas, oil, or coal) with capital costs ranging from \$20 to \$35/kW and operating costs dominated by fuel cost differentials from the base coal costs.

Status: Combustion modification has been widely applied at full scale on new units to meet NSPS on coal-fired utility boilers and for both new unit and retrofit applications on oil- and gas-fired units. Pilot development of retrofit approaches to coal units has progressed to the point where technologies are ready for demonstration on three major categories of existing boilers (tangentially-fired, wall-fired with circular burners, and cell burners). A full-scale demonstration (350 MW) of the PM (pollution minimization) burner on a tangentially-fired unit is now underway at KPL Gas Service's Lawrence Energy Center Unit #5. Sponsors include EPRI, KPL, Combustion Engineering, and the Kansas Electric Utilities Research Program. Burner installation will occur Spring 1987 and the demonstration period is one year. A wall-fired demonstration is planned for Homer City Unit 1 or Unit 2 (650 MW) in mid-1988. Pilot work is underway at Babcock & Wilcox on reburning for specific application to cyclone units under EPRI/GRI sponsorship.

Demonstration Requirements: Remaining development requirements are primarily related to questions of operability. These include demonstrating that $NO_x$ reductions can be achieved without adverse effects on carbon burnout, furnace efficiency, flame stability, slagging or corrosion. In addition to the planned demonstrations of low $NO_x$ burners, systems combining reburning with these burners on tangentially-fired and wall-fired units are needed. Several candidate demonstration projects have been submitted to USDOE in Phase II of the Clean Coal Technology submissions. Three to five additional demonstrations could be completed by 1992-3 covering all categories of pre-NSPS units, including the promising combined systems. Based on experience to date, these demonstrations would cost from $2 to $4 million each.

b. Post-Combustion $NO_x$ Control

Description: Post-combustion $NO_x$ control refers to flue gas treatment methods for conversion or removal of $NO_x$ species external to the furnace. The most common processes involve the injection of ammonia or ammonia-like compounds (urea, isocyanic acid) into the flue gas with or without a catalyst to promote the reduction of $NO_x$ to nitrogen and water vapor. The most extensively developed process is selective catalytic reduction (SCR) in which ammonia is injected into the flue gas at about 800°F in the presence of a vanadium pentoxide catalyst.

$NO_x$ reductions of 80% or more are possible with SCR alone and, if used in conjunction with a low-$NO_x$ burner achieving 50% initial reduction, a combined efficiency of 90% can be obtained. Costs are high, at $75 to $100/kW, and removal costs are estimated at $4000 to $8000/ton $NO_x$ removed depending strongly on initial $NO_x$ levels and assumed catalyst life.

Status: SCR has been commercially applied in Japan to over 7000 MW of coal-fired capacity. Extensive pilot work is underway in West Germany in anticipation of installing SCR on over 60,000 MW of coal fired capacity by 1990. Currently, about seven full-scale installations are operating in Germany. All of this existing and planned application is on low sulfur (less than 1%) coal. US utility experience has been limited to EPRI- and EPA-sponsored pilot projects on coal and a 100 MW demonstration on a gas/oil unit at Southern California Edison's Huntington Beach station.

Demonstration Requirements: The most crucial issue affecting the applicability of SCR in the US is the effect of coal sulfur content on the technology's operability. The $NO_x$ reducing catalyst also promotes the conversion of $SO_2$ to $SO_3$ which, in combination with excess ammonia, forms a troublesome ammonium sulfate compound which contaminates the fly ash and fouls and plugs the air preheater. The latter may be severe enough to render the plant inoperable. This problem is exacerbated by high $SO_2$ levels in the flue gas causing increased $SO_3$ formation,, operation at high $NO_x$ removals, and the deterioration of the catalyst with age. Both pilot- and full-scale development work on high-sulfur US coal is required to determine both the severity of these problems and how they might be resolved.

At least three demonstrations would be required to include coals with a range of properties known to affect catalyst erosion and deactivation and perhaps an additional one to confirm the pilot performance of a low temperature system currently under development in West Germany. These demonstrations, even at modest size (100 - 200 MW), would entail a total cost of $10 to $20 million and require two to four years to obtain a reasonable estimate of catalyst life.

## 5. FLUIDIZED BED COMBUSTION

### a. Atmospheric Fluidized Bed Combustion (AFBC)

Description: AFBC combines emission control of $SO_2$ and $NO_x$ within the combustion process. A hot bed of limestone particles and coal is fluidized by upflowing air. The limestone calcines and removes approximately 90% of the $SO_2$ produced resulting in a dry byproduct. The low combustion temperatures (1400-1600°F) result in inherently low $NO_x$ emissions. AFBC can be built at less capital cost (approximately $1300/kW) and produce electricity at lower busbar costs than conventional pulverized coal plants with FGD. These savings are particularly realized at smaller scale (200-300 MW) because of the increased opportunity for modularity and reduced construction time. Fuel flexibility adds an additional cost saving dimension.

Status: The electric utilities have embarked with EPRI on a program to demonstrate AFBC technology by building and operating three utility-size units. Each project will repower an existing generating unit while extending life, improving emissions control and increasing fuel flexibility. In each case the construction period is less than three years.

- A new 160 MW boiler is being built at TVA's Shawnee steam plant near Paducah, Kentucky by TVA, Duke Power, EPRI and State of Kentucky. The boiler will be a bubbling bed type supplied by Combustion Engineering with underbed feed, and will provide steam to the existing turbine/balance-of-plant of unit #10. Startup is scheduled for mid-1988.
- Conversion of an existing 100 MW pulverized coal unit (Black Dog #2) to a 130 MW fluidized bed is under way by Northern States Power Company. The conversion is of the bubbling bed type, supplied by Foster Wheeler and utilizes an overbed feed system. Operation on coal began in June 1986.
- Colorado-Ute Electric Association chose a 100 MW circulating AFB boiler supplied by Pyropower to repower its Nucla generating station. Startup is scheduled for mid-1987.

Demonstration Requirements: The differing types of applications, scopes of supply, timeframes, fuel fired, and locations make the three AFBC demonstration projects complementary in terms of data they will provide to the electric utility industry. These projects will demonstrate the unique features of AFBC technology such as emission control, fuel flexibility, combustion efficiency, and economics.

Four critical factors require resolution during the demonstration phase. The first is the coal and limestone feed system where wet fines plugging, fines carbon loss and high sorbent use need improvement. Second, combustion efficiency can be improved through optimization of excess and secondary air firing. Third, the heat transfer surfaces must be studied to minimize superheater corrosion and stress as well as tube erosion. Finally, the ash removal and particulate control systems require additional evaluation. Assuming successful completion of the demonstrations, AFBC should be ready for broad commercial application in the 1990s.

### b. Pressurized Fluidized Bed Combustion (PFBC)

Description: The PFBC process is similar to AFBC except that the combustion system operates under approximately 10 atmospheres of pressure and hence can achieve higher thermal efficiency. An additional advantage of PFBC is that the boiler can be shop fabricated and transported to the power plant site by barge or rail. The PFBC turbocharged boiler, because of its relatively small size, is well suited to space constrained sites and meshes well with the life extension of both oil- and coal-fired units. It is equally applicable to new plants as well as those nearing retirement age. Repowering existing plants with PFBC turbocharged boilers promises the lowest busbar energy cost of any coal based generation expansion option available in the 1990s. $SO_2$ emissions potential reduction exceeds 90%. $NO_x$ emissions are approximately 0.2-0.3 lb/MBtu or two to three times less than current federal new source standards due to the low combustion temperatures (1300°-1600°F).

Status: Development, both abroad and in the United States, has brought the PFBC turbocharged boiler to the point of readiness for commercial demonstration. Wisconsin Electric Power Company assembled a project team including Foster Wheeler, Brown Boveri, Research Cotrell and EPRI to make this demonstration a reality by 1990 as part of the DOE Clean Coal Demonstration Initiative. Unfortunately, the project was not selected during Phase I and has since been cancelled. Such a demonstration is still needed to provide the critical performance and scale-up data needed to widely apply the PFBC turbocharged boiler in the United States electric utility industry.

American Electric Power Company (AEP) has negotiated a Clean Coal Demonstration Initiative contract with DOE to use PFBC/combined cycle technology to repower the 60 MW Tidd Plant in Brilliant, Ohio. Additional research to analyze the key process variables and development equipment (e.g., the hot gas cleaning system) is being conducted elsewhere, such as at a 30 MW test facility in Grimethorpe, England with both EPRI and DOE support.

Demonstration Requirements: Similar to AFBC, at least three large-scale (100-200 MW) utility demonstrations are required prior to broad commercial application of PFBC. The key factors requiring resolution include those described under AFBC. Further, additional study is required of the high temperature gas cleaning system. For the combined cycle approach, operation of a gas turbine in association with the PFBC boiler requires effective turbine blade shielding and evaluation of integrated operation and control. Total cost of such demonstrations would be approximately $500 million. Assuming the demonstrations initiate in the late 1980s, PFBC could reach commercial readiness by the mid-1990s.

## 6. COAL GASIFICATION/COMBINED CYCLE (IGCC)

Description: Several different coal gasification processes have been built and operated at lab, pilot, and full-scale throughout the world over the last 50 to 75 years. The technology which has moved furthest toward application in the electric utility industry is the Texaco entrained gasification process. Coal, in dry or slurry form, is exposed to steam, oxygen or air at high pressure (30 atmospheres) producing a synthetic gas. The gas is cooled by generating steam and desulfurized before combustion in a combustion turbine. Heat in the form of steam from the combustion turbine is used to generate additional electricity.

The advantages of IGCC include the ability for phased construction and the extremely low $SO_2$ and $NO_x$ emissions (approximately 99% sulfur removal and $NO_x$ emissions approximately 10 times less than current requirements). Further, IGCC systems can handle most U.S. coal with little difficulty and have the potential for better thermal efficiencies than a conventional steam cycle.

Status: Until recently, integrated gasification combined cycle (IGCC) power plants have been no more than a "paper promise" to the electric utility industry. However, during the last 10 years, various competitive second generation coal gasification technologies have emerged, including Texaco Partial Oxidation, the British Gas/Lurgi Slagging Gasifier, the Shell Gasification Process, the Kellogg Rust Westinghouse (KRW) fluidized bed and the Allis-Chalmers KilnGas process. All of these technologies are applicable to high-sulfur midwestern and eastern bituminous coal and show their greatest economic benefit operating on these coals.

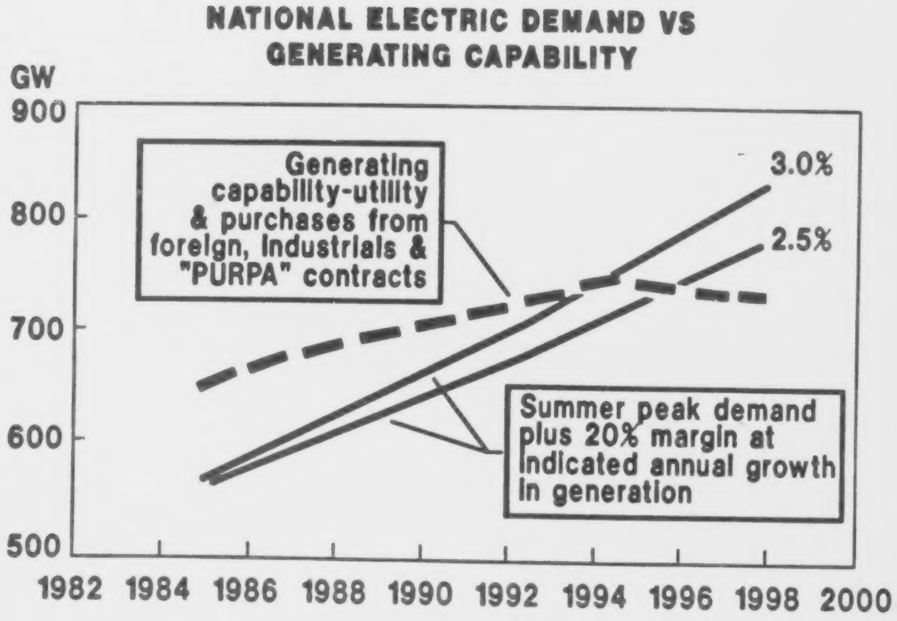
EPRI is evaluating all of these candidate technologies. The major commitment to date has been to the Texaco Partial Oxidation technology. The culmination of this development program to date is the 100 MWe Cool Water Coal Gasification Combined Cycle Power Plant. The Cool Water project has brought together Southern California Edison Company, Texaco, Inc., the General Electric Company, Bechtel, and a Japanese consortium led by Tokyo Electric Power Company, with EPRI as principals. ESEERCO and SOHIO Alternate Energy are also contributors to the project. This team has funded, developed, designed, constructed, and now operates the world's first truly integrated, commercial-scale coal gasification combined cycle power plant.

Testing on high-sulfur coals and obtaining additional data continues at Cool Water, but the early success has placed this technology at the threshold of acceptance by the U.S. electric utility industry. Presently, more than 10 utilities are conducting or planning site-specific designs based on the

Cool Water experience. These utilities are particularly interested in the phased introduction approach since this provides maximum planning flexibility, and reduces both the front-end financial burden and overall revenue requirements.

*Demonstration Requirements*: To provide the necessary base for broad commercial use of gasification combined cycle technology, *at least three or four additional Cool Water scale demonstrations should be undertaken.* Windbox repowering and replacement of an existing boiler with gasification, combustion turbine, and heat recovery steam generator (HRSG) represent areas of additional evaluation. Other factors requiring study include refractory life and heat transfer surface fouling in the gasifier, design conservatisms in the gasifier and gas turbine, the sulfur removal systems (chemical consumption, heat recovery capital cost), costs of the HRSG, and slag disposal.

FIGURE 1



NATIONAL ELECTRIC DEMAND VS GENERATING CAPABILITY

FIGURE 2

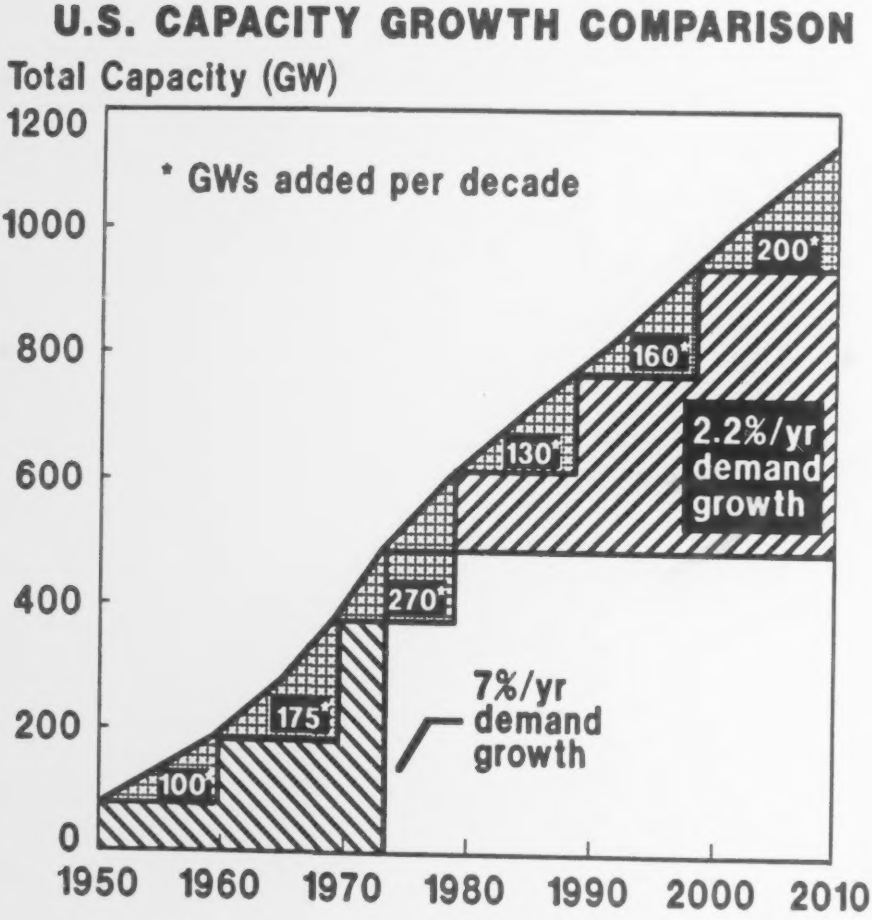

U.S. CAPACITY GROWTH COMPARISON
Total Capacity (GW)
1200
1000
800
600
400
200
0
1950
1960
1970
1980
1990
2000
2010
* GWs added per decade
100*
175*
270*
130*
160*
200*
7%/yr demand growth
2.2%/yr demand growth

FIGURE 3

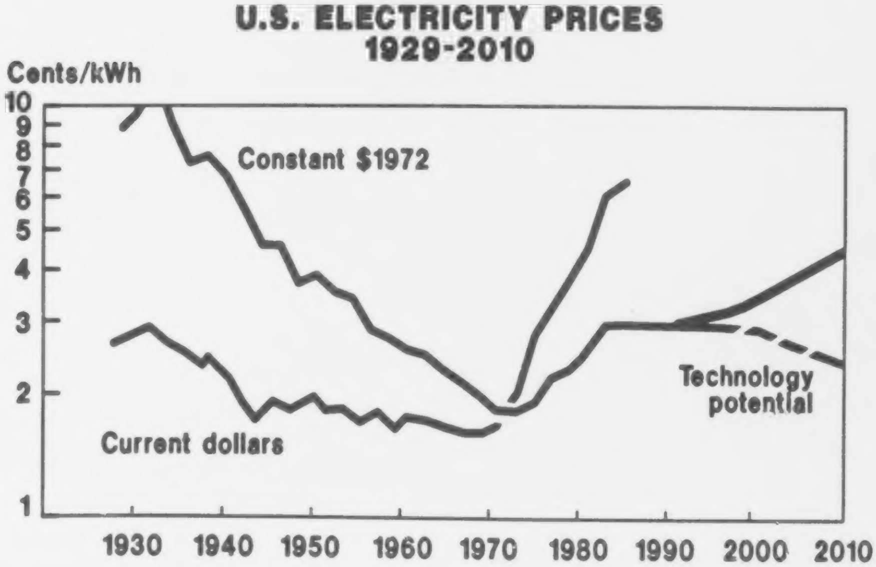

U.S. ELECTRICITY PRICES
1929-2010
Cents/kWh
10
9
8
7
6
5
4
3
2
1
Constant $1972
Current dollars
Technology potential
1930
1940
1950
1960
1970
1980
1990
2000
2010

FIGURE 4

## CLEAN COAL TECHNOLOGY Application

|  | Midwest | E. Coast | West |
|---|---|---|---|
| New plant | 3 | 2 | 1 |
| Repower | 1 | 1 | 2 |
| Retrofit | 1 | 1 | 3 |

1 High priority
2 Moderate priority
3 Low priority

FIGURE 5

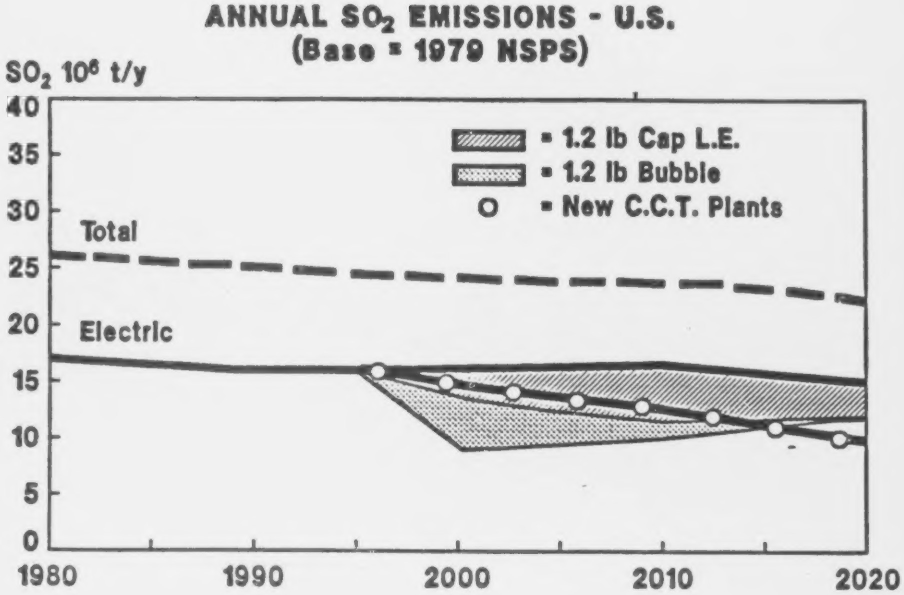

ANNUAL $SO_2$ EMISSIONS - U.S.
(Base = 1979 NSPS)
$SO_2$ $10^6$ t/y
40
35
30
25
20
15
10
5
0
1980
1990
2000
2010
2020
Total
Electric
▨ = 1.2 lb Cap L.E.
▨ = 1.2 lb Bubble
○ = New C.C.T. Plants

FIGURE 6

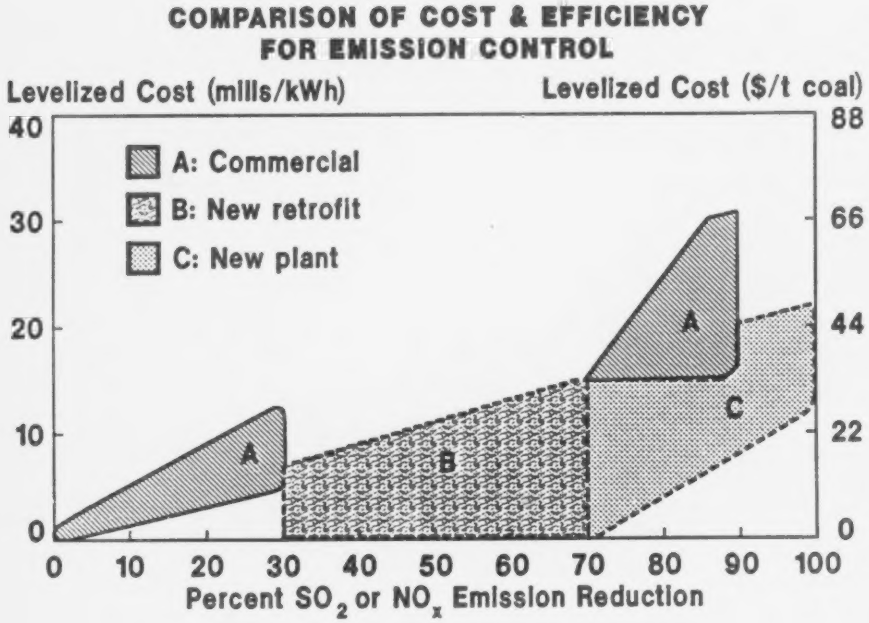

COMPARISON OF COST & EFFICIENCY
FOR EMISSION CONTROL
Levelized Cost (mills/kWh)
Levelized Cost ($/t coal)
40
30
20
10
0
88
66
44
22
0
A: Commercial
B: New retrofit
C: New plant
A
B
A
C
0
10
20
30
40
50
60
70
80
90
100
Percent SO2 or NOx Emission Reduction

FIGURE 7

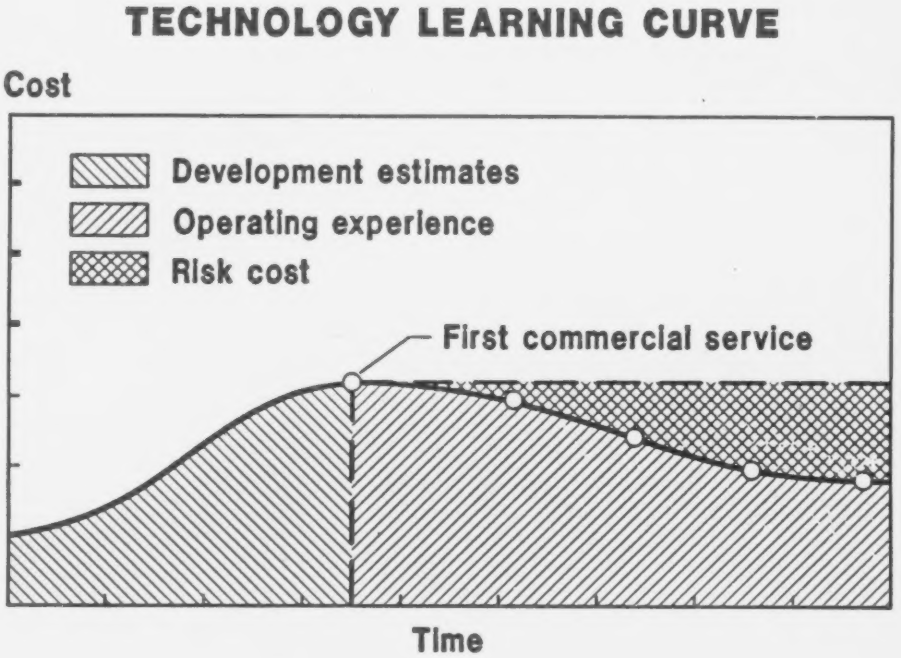

TECHNOLOGY LEARNING CURVE
Cost
Development estimates
Operating experience
Risk cost
First commercial service
Time

TABLE 1
CLEAN COAL TECHNOLOGY APPLICATIONS AND RISKS

| TECHNOLOGY | CAPITAL COST ($/KW)* | NET COST EFFECTIVENESS $/TON $SO_2$ OR $NO_X$ REMOVED | APPLICABILITY |  | RISK FACTORS REQUIRING RESOLUTION |
|---|---|---|---|---|---|
|  |  |  | RETROFIT | REPOWER/ NEW |  |
| 1. Coal Cleaning and Upgrading |  |  |  |  |  |
| A. Advanced Physical Coal Cleaning | 60-100 | 400- 600 | X | X | • Degree of sulfur removal<br>• Btu recovery<br>• Increase in coal moisture<br>• Economic agglomeration technology |
| B. Low Rank Coal Upgrading | 60-120 | 400-1000 | X | X | • Capital cost of equipment<br>• Btu recovery<br>• Product quality |
| 2. Wet FGD |  |  |  |  |  |
| A. Advanced Conventional FGD | 200-300 | 400- 600 | X | X | • Capital costs of redundancy and materials<br>• O&M cost savings through elimination of reheat |
| B. Advanced Regenerable FGD | 300-400 | 500- 700 | X | X | • Capital costs of materials and redundancy<br>• O&M costs associated with membrane plugging, sorbent use |
| 3. Dry $SO_2$ Control |  |  |  |  |  |
| A. Furnace Sorbent Injection | 50- 75 | 700- 900 | X |  | • Boiler impacts<br>• ESP Upgrade costs<br>• Waste management |
| B. Duct Sorbent Injection | 50-100 | 500-1000 | X |  | • Duct deposition (calcium systems)<br>• Baghouse performance (hybrid system)<br>• Soluble wastes, $NO_2$ plume, sorbent cost and availability (sodium system)<br>• Particulate control/humidification<br>• Waste management |

| TECHNOLOGY | CAPITAL COST ($/KW) | NET COST EFFECTIVENESS $/TON $SO_2$ OR $NO_x$ REMOVED | APPLICABILITY | | RISK FACTORS REQUIRING RESOLUTION |
|---|---|---|---|---|---|
| | | | RETROFIT | REPOWER/ NEW | |
| 4. $NO_x$ Control | | | | | |
| A. Low $NO_x$ Combustion and Reburning | 5- 35 | 100- 500 | X | X | • Effects on carbon burnout, flame efficiency and stability, slagging and corrosion |
| B. Postcombustion | 75-100 | 1000-4000 | X | X | • O&M costs of catalyst replacement<br>• Availability loss due to air heater cleaning |
| 5. Fluidized Bed Combustion | | | | | |
| A. Atmospheric | 600-1600[a] | 200- 500[b] | | X | • Capital and O&M costs of heat transfer surface and solids handling systems |
| B. Pressurized | 800-1500[a] | 200- 450[b] | | X | • Capital costs as per AFBC<br>• O&M costs of sorbent utilization and gas turbine maintenance |
| 6. Integrated Gasification Combined Cycle | 1300-1900[a] | 200- 400[b] | | X | • Capital costs of design conservatism<br>• O&M costs of heat transfer fouling, refractory & sulfur recovery<br>• Availability loss during startup |

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* For an approximately 250 MW retrofit/repower on medium to high sulfur coal (2.5-4% sulfur) in 1986 dollars.

[a] Total installation cost range reflects repower and new applications.

[b] Net $SO_2/NO_x$ control cost effectiveness based on fraction of total capital and operating cost assigned to emission control.

## TABLE 2

## PROJECT SUBMISSIONS RECEIVED BY DOE CATEGORIZED BY TECHNOLOGY

| TECHNOLOGY | NUMBER | TOTAL VALUE* ($X10$^6$) |
|---|---|---|
| FLUE GAS CLEANUP | 52 | 524 |
| FLUIDIZED BED COMBUSTION | 15 | 611 |
| SURFACE COAL GASIFICATION | 10 | 1,190 |
| COAL PREPARATION | 29 | 665 |
| COAL FIRED TURBINE | 4 | 3 |
| ADVANCED COMBUSTORS | 11 | 160 |
| ALTERNATIVE FUELS | 4 | 133 |
| FUEL CELLS | 1 | - |
| MHD | 1 | 400 |
| NON-TECHNOLOGY SPECIFIC | 5 | 43 |
| IRON AND STEEL PROCESSES | 2 | - |
| OTHER | 3 | 8 |
| TOTAL | 137 | 3,737 |

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* 83 OF THE 137 RESPONSES INCLUDED COST ESTIMATES.

Dr. BALZHISER. Thank you. I will remain for questioning.

Senator FORD. Thank you very much, Doctor. We are very pleased that the Chairman of the Full Committee is here.

Doctor, what environmental and economic benefits, dollars and cents and otherwise, will the U.S. realize by using emerging clean coal technologies, instead of the conventional scrubbers?

You alluded to that. You've a very good statement in a portion of your testimony, but let's have that as part of the record to answer a question.

Dr. BALZHISER. Do you want me to take that up right now?

Senator FORD. Yes, sir.

Dr. BALZHISER. I think the important thing to recognize is that the clean coal technologies to which we are referring are technologies that build the environmental control into the technologies at costs that are comparable to conventional technology.

So we believe that an investment in these technologies is an investment that will be sustained over some period of time, that the productivity of the plants and the protection of the environment will be more enduring than if the alternative of retrofitting plants with limited remaining life at very high costs is the decision.

Senator FORD. Is there a specific statement that you can make as it relates to how much emission reduction will be made by scrubbers and how much emission reduction would be made by the new clean coal technologies that we're on the edge of bringing on line?

Dr. BALZHISER. Mr. Chairman, I think that's a matter of what's required. I think one can get whatever emission reduction is desired with scrubbers. I think it would be at a very high cost to the society.

I think you can get comparable costs with the clean coal technologies, as I say, at lower costs and with a much more sustained protection of the environment. But to translate that into dollars or specific tons in the absence of a particular reference frame, I don't believe I can do.

Senator FORD. But you do indicate that as it relates to costs to society and other items, that the new clean coal technologies would be much better than to just move immediately to scrubbers.

Dr. BALZHISER. We made an estimate that if we were to take the costs that we think would go along with some of the proposed pieces of acid rain legislation of significant numbers of billions of dollars and if instead of spending those dollars on retrofitting existing plants, they were invested in clean coal technology for new plants, that it would provide close to half of what would be required in the way of capital expenditures to meet our electricity demand requirements over the next 30 years.

That's an order of magnitude we think is pretty significant.

Senator FORD. That is very, very significant.

Let me ask you one other item, one other question; and then I'll turn it over to Senator Johnston.

As noted in your testimony, you have been a participant in the Cool Water Combined Cycle Coal Gasification Plant in Daggett, California. As I understand it, a large portion of the funding is from the former Synthetic Fuels Corporation funds.

The agreement you made back—I guess it was 1983—was for a phased approach to this project. Phase 1 runs from 1984 through 1989, I believe, with Phase 2 to begin in 1989.

Am I correct in that assumption?

Dr. **Balzhiser**. I believe so. But let me check that and respond to you later for the record.[1]

Senator **Ford**. All right. Can you describe the success—at least I presume that it has been successful—of Phase 1 of the program?

Dr. **Balzhiser**. Yes, sir. Let me just characterize it very briefly.

The emissions from that plant are less than the emissions from the gas-fired combined cycle plant sitting adjacent to it, right next to it. In California one must keep coal covered at all times, so the coal comes in in covered cars. It never sees the light of day. There's no dust; there's no anything.

It's also fair to say that we have been learning precisely the kind of things we expect to learn from these demonstrations. We have operated it with three different coals; two of them Eastern high sulfur coals, and in each case we went through very difficult start-up procedures to develop an understanding of what's different from a Kentucky or a Pittsburgh coal as compared to the Utah coal for which the plant was designed.

So we're learning a good bit. If we were to do it again, we would do it differently. And I suppose the third time we would do it still differently.

That's what we mean by demonstration. That's what we mean by risk reduction, ultimately getting down to a technology that's reliable and is cost effective.

But I think we have met our objectives.

Senator **Ford**. What are the prospects then for Phase 2 that's scheduled, according to my information, in 1989?

Dr. **Balzhiser**. That I do not know. That's a decision that I suppose Southern California Edison will be making.

Senator **Ford**. Senator Johnston.

## STATEMENT OF HON. J. BENNETT JOHNSTON, A U. S. SENATOR FROM THE STATE OF LOUISIANA

The **Chairman**. Thank you, Mr. Chairman.

Mr. Chairman, I'm sorry I was late this morning. I was in the final stages of filling out my tax return, and I found a mistake in my favor. So I owed the Government more money, so it took me more time to recover emotionally from that.

Senator **Ford**. How did you vote on the new tax bill? Like I did.

The **Chairman**. That one didn't have anything to do with it—the tax bill.

Senator **Ford**. I thought maybe it might.

The **Chairman**. But, Mr. Chairman, I'm glad we're having these hearings.

The new-found problem of the nation is the approaching energy crisis, not the present energy crisis, but the approaching one.

I made a little talk last night. I said there's a new bounce in the step of energy lobbyists. There's a new twinkle in the eye of oil company people. There's a new realization on the part of everyone else that we are going to be short of energy very soon. It's certainly a matter of years. I would guess by—my guess is by the early 1990's, maybe by the latter part of this decade, we're going to have severe difficulties with the price again inching up.

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[1] The information was not received.

It is only a question of how soon OPEC can get its act together, enforce its discipline. And I would suspect that that is a question of how much more the market narrows in terms of supply and demand.

The market narrowed at least by a million barrels a day in the last year when our imports went up by that much. So I would expect it to be sooner rather than later.

And certainly by almost any estimate, by the time we could get this technology, or any other substitute technology on line, the fat is going to be in the fire, as far as pricing is concerned.

So we're already late as far as a substitute for oil and gas. We need to pursue those two technologies as fast as we can.

But we also need a substitute. Now, we tried the Synthetic Fuels Corporation. Mismanaged as it was by this Administration, it was still, I think, a very viable idea because we weren't building synthetic fuel plants or trying to get commercialization of technologies for the 1980's. We were trying to get it for the next crunch.

Unfortunately, we let that go. This technology, clean coal technology, is a very cheap technology in terms of comparison to what the total cost is.

I mean, the Byrd bill is, I think, $3.5 billion. That is a very modest price, and it has payoff. I don't want to prejudge any of the particular technologies, but I think it is clear that there is great promise in these technologies.

I've seen the Cool Water plant. It, of course, is not economically viable at this time. It's a demonstration plant, an experimental plant, if you will, a lot of horns and whistles built into it for the purpose of testing and evaluation and one-of-a-kind sort of things that would be less expensive, as that is replicated more and more, and as indeed changes are made, modifications, to perfect the technology.

So I hope that we hear more about the promise of what this can do. I don't mean "Pollyanna" testimony, but real tough-minded testimony about what we can achieve.

And then if we are satisfied that we can achieve it, then we've got to fund it. We've got to find those dollars there somewhere.

I mean, it's silly for a nation on the eve of an energy crisis, when it can spend some modest dollars to use its greatest energy resource—that is, coal—and not to do it is foolhardy.

So I hope we will find the basis in these hearings on which to do that.

Now, Doctor, with respect to the Byrd bill, he has provisions in this bill that would direct FERC in effect to declare these prudent expenditures, if they're declared eligible, so as not to get caught on the horns of that ex post facto dilemma that says, "After you make your decision and spend your money, then to have somebody second guess you *x* years later."

Is that necessary in order to use clean coal technology?

Dr. **Balzhiser**. Senator, I think you might better ask that question of my colleagues on the panel who are actually in that position as executives in utilities.

But I think your point is a very valid one and a good answer to Senator Ford's early question.

Clearly, the prudency reviews that utilities are undergoing nationwide as a result of investments in nuclear power are good evidence that they're exposed to second guessing.

That's the kind of risk that one certainly has to be concerned with when you're dealing with a new and quite different type of technology.

The **Chairman**. I guess I could ask the question in another way, and I think the question really answers itself.

That is, this technology is an evolving technology. It is new; it is uncertain in terms of exactly what the economics are and what the payoff will be.

We know it will clean up coal. We know that it can be made more efficient, but we don't know exactly how efficient it can be made.

Dr. **Balzhiser**. That's correct.

The **Chairman**. So I would guess the answer is—and we will hear, I think, from subsequent witnesses—that we must provide some prudence protection.

I'll ask the other witnesses with respect to state PUC's what we can do in that respect. I don't know legally whether you can order that, whether we can jurisdictionally affect what they do.

But I would hope so, because if we prudently design a technological and legal framework here that says after review that certain technologies are eligible, then I would hope that we won't be second guessed by state PUC's who later say, "Well, that turns out not to be quite as efficient as we thought. Therefore, stockholders, you're going to have to pay."

This business of soaking the stockholders—and maybe they deserve it sometime—but a lot of times the stockholders get zapped because of delays of the regulators, especially in the case of nuclear energy.

The NRC came in and retrofitted in many respects certainly inefficiently, if not unnecessarily, and raised the costs. And then the regulators came in and said, "Well, you see, that costs you 2.5 times what it was projected to cost. And it costs that much because the regulators made it cost that much."

Dr. **Balzhiser**. I might add, Senator, you obviously have a very good understanding of the problem the industry faces.

The **Chairman**. Well, I made a talk not too long ago; it was to the effect that industry is simply not going to build any new nuclear plants or any new coal plants. Indeed, they haven't.

There have been no nuclear plants in what—about 14 years, is it? Since 1976.

And no new coal plants since about 8 years, as I recall. That's because I think they have learned that it's better to err on the side of not building than building one that you may not need.

If you have too little electricity, you might have blackouts, brownouts, lack of growth, lack of new industrial development, lack of jobs, which is terrible for the public but it's okay for the stockholders, because they're going to sell all the electricity they can make.

But that's better, if you're an owner or a stockholder, than having to go broke and maybe lose your job if you're the manager of one of these plants.

So we've got to figure out a way to prudently put this new coal technology on line. I think under Senator Ford's leadership we'll find that way, because I know he is interested in the subject matter.

Thank you very much, Doctor.

Senator FORD. Thank you very much, Senator.

We'll now ask Mr. Dowd to come forward and give his statement. Doctor, if you'll just remain at the table.

## STATEMENT OF A. JOSEPH DOWD, SENIOR VICE PRESIDENT AND GENERAL COUNSEL, AMERICAN ELECTRIC POWER SERVICE CORP.

Mr. DOWD. Mr. Chairman and Members of the Committee, my name is Joseph Dowd. I'm Senior Vice President and General Counsel of American Electric Power Service Corporation.

I appear here today on behalf of the Clean Coal Technology Coalition.

At the outset, Mr. Chairman, on behalf of the Coalition, I'd like to thank you and other members of the Committee who have been strong and effective proponents for the Clean Coal Program.

We believe it's appropriate for this Committee to conduct these hearings. Most recently Clean Coal Technology development has been examined only in the context of its potential for emissions reductions.

Now, while that inquiry is important, the successful demonstration and the widespread deployment of these technologies will enhance the security of our nation's power supply by ensuring a sustained and expanded use of an abundant domestic resource, coal, to meet the nation's growing energy requirements.

In implementing the Clean Coal Program, there must be strong emphasis on a strategy that encourages the development of a wide variety of new technology options. We would urge, therefore, that every consideration be given to supporting the Phase 2 Clean Coal Demonstration Program contemplated in the President's initial budget request made at the beginning of this year.

The Federal Government can support an accelerated demonstration program such as that envisioned by the Phase 2 program, while still embarking upon a concurrent strategy to accelerate deployment of clean coal technologies that have already been, or will in the near term be, demonstrated.

The Pressurized/Fluidized Bed Combustion technology under development and demonstration by American Electric Power, in cooperation with the Department of Energy and the State of Ohio is a good example of a technology that is ripe for demonstration, but is not ready for commercial deployment.

As one of the nine demonstration projects selected by DOE, our demonstration is scheduled to be completed in 1993. If the demonstration is successful, the next step would be to construct a commercial-size facility which would be available in the late 1990's.

The utility industry likely will consider use of this technology only after it has been successfully operated at a commercial-size facility. Other clean coal technologies have yet to reach even the demonstration stage.

The current program, if extended and enhanced as contemplated in the President's January budget request, might assist in these demonstrations as well.

The Coalition is concerned about the requirement of the current clean coal program, that the private sector not only bear at least 50 percent of the cost of demonstration projects, but that it also repay the Government's contribution.

Industry has willingly come forward with cost sharing commitments. However, for industry to repay the Government's contribution, as well as to provide at least half the money itself, will have a chilling effect which inevitably will reduce industry response to any subsequent solicitation for either demonstration or deployment projects.

As you know, President Reagan recently announced his commitment to implementing the Report of the Special Envoys on acid rain by requesting the appropriation of $850 million for the next two fiscal years.

He's also committed to the expenditure of a total of $2.5 billion over a 5-year period and has charged the Vice President's Task Force on Regulatory Relief with the job of examining and identifying current legal and regulatory incentives and disincentives to the deployment technology.

In addition, the Majority Leader of the Senate who has been the champion for clean coal technology development earlier this week introduced Senate Bill 879, the Clean Coal Technology Deployment Bill.

We strongly support both the President's initiative and the Byrd bill. The President has pledged his Administration to the development of clean coal technologies with $850 million up front in fiscal years 1988 and 1989.

The experience of industry with other government programs designed to discourage energy technology development has left the private sector somewhat skeptical.

Therefore, this up-front commitment of significant Federal resources is most gratifying. We also suggest that the President's initiative be combined with Senator Byrd's proposal, so that it's clear that the overall program is oriented first and foremost toward addressing the energy and environmental needs of the United States of America.

American taxpayers are being asked to provide a large number of tax dollars to bring on these new technologies. We have an obligation, therefore, to make sure that these dollars are expended for the primary benefit of the security of energy supply in the United States and for the enhancement of the environment of the United States.

If there are secondary benefits to other companies, so much the better. In achieving these ends, the Administration's initiative must not focus too heavily on the deployment of commercial or near-commercial technologies, thereby perhaps neglecting the demonstration of promising new technologies.

The Phase 2 demonstration program should be specifically retained to assure that a balance is achieved between continued demonstration and the initiation of a deployment program.

Also, such deployment programs should not be confined to the retrofit of existing plants, but should include the application of these technologies to new power plants as well.

The President's announcement highlighted the need to support technologies that can be applied to existing facilities. We believe that that emphasis should be extended to the next generation of power plants that will be needed to produce electricity for our nation.

Next, I'd like to briefly set forth the Coalition's views regarding some of the ingredients that we believe a well-structured demonstration and deployment program might contain.

For example, Federal financial aid should be construed as Government's contribution to minimizing the risks associated with the introduction of a first-of-a-kind technologies at a scale appropriate for commercial utility use.

As such, it should compensate for that risk not normally borne by the utility industry when it installs plant and equipment having sufficiently acceptable performance guarantees.

If Federal assistance were to be confined to the risk component of a project, the Government's cost sharing would be held to a minimum and would result in highly leveraged projects.

It would also enable Federal financial assistance to be spread over a larger number of worthwhile projects.

We also believe that Federal assistance should be limited to a finite number of commercial projects for each demonstrated technology. The number of projects receiving deployment assistance may vary, depending on the technology involved.

Federal assistance for a given technology in a deployment program would end at the point where that technology has available sufficient vendor guarantees to support its commercial use.

The Congress must also appreciate the salient fact that the utility industry does not play on a level field with the rest of the private sector, in terms of new technology development.

As regulated entities, to recover costs utilities must demonstrate to the satisfaction of regulators that costs are both just and reasonable and prudently incurred.

The current regulatory environment is risk averse, very much risk averse. The unfortunate effect of contemporary utility regulation is both to minimize risk and to discourage risk taking.

In this kind of a climate, a utility initiative, either to demonstrate or to deploy an unproven technology, may result in a substantial or even a total disallowance of its cost if the project fails, in which case the loss is borne by the utility stockholders.

If a technology is successful, however, it's the ratepayers and not the stockholders who reap the rewards. Now this kind of "heads you win, tails I lose" prudency, Catch 22 is obviously not conducive to the accelerated deployment of first-of-a-kind technology.

The regulatory climate must be modified, if industry is to make the commitments that new technology introduction demands. The

Coalition thus endorses the Federal regulatory incentives proposed in Senator Byrd's legislation and the emphasis inherent in the direction to the Vice President's Task Force to examine existing regulations with the goal of identifying and recommending incentives that will accelerate deployment.

Finally, the Clean Coal Deployment Program cannot succeed without the support and the cooperation of the States. Senator Byrd's proposal recognizes this need by encouraging the States to modify their regulations so as to foster investment in new technologies.

With the help of the States, the program can be a true Federal/State/industry partnership that will yield significant benefits to the nation's ratepayers and taxpayers.

Having endorsed the Clean Coal Program, the President should use the influence of his office to encourage States to become partners in the demonstration and deployment of new clean coal technologies.

Success in these efforts will benefit the consumer and the environment.

Mr. Chairman, this concludes my statement. I do have a more detailed statement on behalf of the Coalition which I would appreciate having submitted for the record.

Senator FORD. Mr. Dowd, your further remarks will be included in the record in total.

[The prepared statement of Mr. Dowd follows:]

# WRITTEN STATEMENT OF THE
# CLEAN COAL TECHNOLOGY COALITION

SUBMITTED BY A. JOSEPH DOWD
SENIOR VICE PRESIDENT AND GENERAL COUNSEL
AMERICAN ELECTRIC POWER SERVICE CORPORATION

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
U. S. SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

April 2, 1987

## I. INTRODUCTION

This written testimony is submitted on behalf of The Clean Coal Technology Coalition. The Coalition is organized for the specific purpose of encouraging the demonstration and subsequent deployment of new clean coal technologies. (A list of the Coalition members is attached to this statement.) This statement addresses the need for a Federal clean coal technology deployment program.

## I. THE NEED FOR FEDERAL INVOLVEMENT IN THE DEVELOPMENT AND COMMERCIAL DEPLOYMENT OF EMERGING CLEAN COAL TECHNOLOGIES

The United States has recently taken the first steps to bring new and cost effective technologies which use coal in an environmentally acceptable manner to the commercial marketplace. The successful demonstration, followed by rapid and widespread commercial deployment of clean coal technologies, will permit the continued and increased utilization of American coal resources in an environmentally acceptable and cost effective manner.

An adequately funded and technologically diverse demonstration program will allow sufficient demonstration of these new technologies to give the utility industry and their regulatory bodies adequate assurance of their technical capabilities. To ensure that a diverse number of technologies are demonstrated, the Coalition supports the appropriation of $350 million remaining in the Clean Coal Technology Reserve. The purpose of this appropriation would be to implement the second phase of the demonstration program. Upon successful completion of this program the utility industry will then have several additional options with which to meet power needs in the next decade and beyond.

However, regulatory and financial constraints, which accompany the technological uncertainties of first-of-a-kind, immature units, pose serious impediments to commercial deployment of clean coal technologies. Even with the success of the current demonstration programs there is little certainty that the electric utility industry can incorporate these technologies in a timely manner. To ensure the rapid and widespread commercialization of emerging clean coal technologies the Congress and the Administration should consider and adopt a clean coal technology deployment program.

The Clean Coal Technology Coalition (CCTC) has examined a variety of regulatory changes and legislative initiatives which address the critical financial and regulatory issues associated with the deployment of clean coal technologies in the utility sector. While any Congressional initiative to develop a deployment program is likely to be structured as a federal initiative dealing only with policies administered by federal agencies, consideration needs to be given to means by which individual states will become involved in also deploying these technologies. Several suggestions included in this statement could be directed toward encouraging such favorable state action.

## II. THE NATIONAL INTEREST IS BEST SERVED BY FEDERAL SUPPORT FOR THE DEPLOYMENT OF CLEAN COAL TECHNOLOGIES:

In the operation of the U.S. economy the process of technology development, demonstration, and commercialization to meet consumer product demand is largely the responsibility of the private sector. In areas such as chemicals and electronics, the process of technology development and deployment in the marketplace has been successfully accomplished by private, risk-taking enterprises seeking to maximize profitability through technology innovation. The major exception to this general rule is in the defense sector where federally funded defense R&D is generally followed by federal support for demonstration and deployment activities even where the major technological risks have been removed.

Unlike other sectors of the economy, the incentive of economic reward for the technology risks taken are not present in the case of regulated companies whose financial performance is significantly affected by direct state and/or federal regulation. When coupled with the substantial technical, financial and regulatory risks associated with the full scale commercialization of first generation clean coal technologies, innovation can be stifled in a regulated environment.

Considering the national importance of providing environmentally acceptable, cost effective electric power, which is generated from vast domestic coal resources, it is critical that a concerted effort be made to reduce or eliminate the disincentives which currently inhibit the commercialization of emerging clean coal technologies. In order for such an effort to be successful, the federal government must assume a leadership role. Such federal initiatives could produce the following national benefits:

1. Use of cost effective and efficient clean coal technologies would provide a basis for minimizing the costs of further emissions

reductions from existing plants should such reductions be needed. Further, the costs of power production from new plants designed to meet incremental demand could also be minimized. Therefore, widespread commercialization of these technologies would benefit both industrial energy users and the general public.

2. Clean coal technologies have the potential to permit the utilization of all types of U.S. coal in an environmentally acceptable manner. Thus, the domestic markets for American coal would be maintained and could be significantly enhanced. Also, when retrofitted to existing facilities, significant reduction in air emissions could be realized in the immediate future.

3. Such technologies may also encourage the export of U.S. coal and American-developed clean coal technologies. Further, the use of our domestic coal resources would help to assure U.S. energy security by sustaining and increasing reliance upon an abundant domestic energy supply.

4. Several of the new clean coal technologies are shop fabricated and modular in design. They can be constructed relatively quickly, thereby reducing construction time and related financing charges. Such technologies provide an attractive option for some utilities to more closely match system capacity additions with actual load growth.

The deployment initiative advocated herein is intended to assure maximum public and private benefits from the investments made in the demonstration program.

## III. CURRENT IMPEDIMENTS TO THE DEPLOYMENT OF CLEAN COAL TECHNOLOGIES:

### A. The Demonstration of Promising Clean Coal Technologies Is Not Yet Successfully Completed.

Successful implementation of the first phase of the federal clean coal technology demonstration program, as represented by successful execution of the selected technology demonstrations, must be completed to reduce the technology risks inherent in the application of any new technology. A further phase II of the demonstration program directed at retrofit, repowering, or modernization applications must also be completed in order to broaden the technology base of the program and assure maximum public benefit for the public and private funds expended.

B. The Potential of Acid Rain Control Legislation.

If a regulatory program designed to achieve significant additional sulfur emission control is initiated prior to the commercial applicability of advanced clean coal technologies, the technology options available to the utility industry will be limited. The possibility that the Congress will enact more stringent emission control legislation has created an enormous disincentive to the development of clean coal technologies. A regulatory program to achieve compliance with a certain prescribed emission level, within the time frames advocated by some Congressional proponents of acid rain control, will not only be costly but will also preclude the development and deployment of clean coal technologies as utilities will seek to comply with new regulations by utilizing already proven emission control equipment. Unfortunately, existing technologies when applied to near term emissions reduction may result in significant incremental costs to ratepayers over the project life when compared to other, more advanced, alternatives which may not yet be fully commercial.

C. Public Utility Commission Oversight and Prudency Determinations.

The potential for retrospective prudency review of projects involving advanced technologies act to discourage utilities from any such commitments. In addition, utilities have expressed concern that uncertainties associated with future changes in environmental regulations make it extremely difficult to consider technology-based, capital-intensive investments without some level of protection against subsequent "second guessing" by their regulatory commissions. This judgment by a regulatory commission could be made long after substantial commitments and expenditures have been made.

D. Impediments and Disincentives Related to Market Uncertainties.

There are other impediments to the eventual deployment of clean coal technologies that relate to current uncertainties in how critical elements of the marketplace will change in the near future. These market uncertainties are caused by the inability of utility and private analysts to adequately predict what requirements may exist in the future for meeting load growth, for responding to changing fuel prices, and for coping with the ability of independent power generators, such as cogenerators, to compete with existing regulated power companies.

While market-based uncertainties are more properly the responsibility of the utilities and others involved in the use of new technologies, both federal and state governments have a significant influence on some of these issues, and thus there is much that government can do to minimize the difficulty these uncertainties have on utilities.

## IV. PROPOSED THREE-POINT CLEAN COAL TECHNOLOGY DEPLOYMENT PROGRAM:

To reduce the risks related to the commercial deployment of clean coal technologies, the Coalition recommends adoption of a three-point clean coal technology deployment program. This program would be designed to assist in the commercialization of a limited number of pioneer clean coal projects. These commercial projects would provide the electric utility industry and others with the evidence needed to choose from a variety of technologies for market-based applications. In order to achieve this stage of technology maturity, it is necessary to assist in reducing the financial and regulatory risks associated with an immature technology. The three-point deployment program, described below, is intended to reduce these financial/regulatory risks.

### A. Authorization of a Multi-Year Deployment Program.

A multi-year program, including significant federal funding of amounts in the range of $2.5 to $3.5 billion as recommended by the President and Senator Byrd, respectively, for a period of ten years, should be authorized to encourage the deployment of a specified number of clean coal technology projects. These funds would be in addition to the approximately $400 million already appropriated for the clean coal technology demonstration program and the additional $350 million that should be appropriated out of the Clean Coal Technology Reserve for further demonstrations.

The funding sought under this proposed deployment program should be made available only in that period of time when demonstrations of various clean coal technologies will have been completed. In this way, the deployment program will provide a limited, but direct, economic incentive to those utilities and others willing to undertake the risks associated with commercial-sized, first-of-a-kind, projects using new clean coal technologies. By providing for a ten-year program sufficient time should also be made available to account for the different stages of development of various clean coal technologies. The economic incentives should be specifically directed toward risk sharing or mitigation of risks associated with early commercial-sized projects.

Once the clean coal technology deployment program has been authorized the Congress should appropriate the entire amount in advance but retain the right to determine the maximum appropriate level of government participation in each fiscal year in order to assure that sufficient funds are made available to support the planned technology deployment program. Furthermore, the funds appropriated for the deployment program should be made available to utilities as a grant-in-aid of construction and/or operation. In this way the maximum benefit will be derived from federal participation in the deployment program.

### B. Suggested Changes to Existing Regulations.

1. By legislation or changes to existing regulations, the federal government should actively encourage deployment of successfully demonstrated clean coal technologies by adopting regulatory incentives that will provide a participating utility with encouragement and regulatory certainty that treatment before the Federal Energy Regulatory Commission (FERC) will be favorable. Such regulatory incentives like those called for in S.879, introduced by Senator Byrd, would provide much needed and welcomed revisions for the treatment of new technologies.

### C. Federal Involvement at the State Level.

In recognition of the fact that the deployment of clean coal technologies can be stymied -- or alternatively greatly facilitated -- by the independent actions of various state regulatory commissions, the Secretary of Energy and the Administrator of the Environmental Protection Agency should utilize the authorities of their respective offices to explain the federal clean coal technology deployment program to the governors and appropriate state agencies and regulatory bodies involved in the regulation of electric utilities.

The Administrator and Secretary should also encourage the appropriate state agencies and regulatory bodies to adopt those regulatory incentives provided at the federal level to encourage the deployment of clean coal technologies.

## V. CONCLUSION

Clean coal technologies provide the opportunity for sustaining and increasing the use of U.S. coal, for meeting the future energy needs of this country in an efficient and cost-effective manner, and for protecting our environment. These objectives can be achieved rapidly if the nation will commit to a federally-assisted clean coal demonstration and deployment program.

On March 18, 1987, President Reagan committed to the implementation of a multi-year clean coal program; on March 30, 1987, Senate Majority Leader Robert Byrd introduced legislation, S. 879, designed also to deploy new clean coal technologies. The Congress is urged to consider these proposals and to adopt a program that will benefit our environment and provide the United States with greater domestic energy security.

Senator FORD. I have just a couple of questions for you and then I'll call on Senator Johnston.

I think we need to get on the record one question, and that's why should the Federal Government provide both financial assistance and regulatory relief? Wouldn't one or the other be enough?

Mr. DOWD. I think that would depend upon the technology involved, Senator. It may well be that in certain instances one or the other would be enough. And in certain further instances, it may be that certain regulatory incentives may be sufficient to encourage the deployment of these technologies.

I do think that it depends in large part upon the degree of risk involved in the particular technology, and I do think that Senator Byrd's bill has this kind of flexibility contained in it.

Senator FORD. You set out in your statement that it was necessary for the Federal Government to participate in the commercial deployment of clean coal technologies. You referred to the regulated industry.

You also made a statement in your remarks that all the money for your proposed Federal deployment programs should be appropriated—and I quote—up front, end of quote; to be spread out over several years.

What purpose does that serve?

Mr. DOWD. Well, by having the money appropriated up front, it gives a high degree of security to the private sector that this program will move forward. It enhances the ability of the private sector to plan its involvement in technology development.

I mentioned in my oral statement some disenchantment, perhaps on the part of industry with other programs. I had in mind there particularly the syn fuels program. Therefore, a major commitment of Federal resources up front, whether it's the entire amount, or as President Reagan is suggesting, $850 million over a 2-year period would, we think, provide a very favorable climate for industry to move forward with the deployment of these technologies.

Senator FORD. Senator Johnston.

The CHAIRMAN. Thank you, Mr. Chairman.

Mr. Dowd, how critical to the availability of these technologies is funding as per the Byrd bill? How much will funding accelerate the use of these technologies?

Mr. DOWD. Well, funding as distinct from the regulatory incentives?

The CHAIRMAN. Yes.

Mr. DOWD. I think funding is primarily necessary to accelerate the development of these technologies. Now, I don't want it to be misunderstood.

I think that eventually in time industry, without Federal funding and without regulatory incentives, would eventually develop many of these technologies, but we're talking about a much more protracted period of time, I think a number of decades.

The Federal funding, I believe, is absolutely essential to the accelerated development of these clean coal technologies.

The CHAIRMAN. When will these technologies be available, and how much acceleration would be provided within a given level of dollars?

Mr. DOWD. Well, this is a difficult question obviously to answer.

My understanding is the program that is contemplated here could accelerate the development of these technologies by at least ten years.

The CHAIRMAN. By ten years.

Do you expect that these kinds of technologies are going to be able to be used in a modular way, 100 to 200 megawatts?

Mr. DOWD. That is my understanding, but I suspect that Dr. Balzhiser might be in a better position to answer questions of that nature.

The CHAIRMAN. What do you think, Dr. Balzhiser?

Dr. BALZHISER. Yes, sir. These technologies clearly lend themselves to modular additions to the grid.

The CHAIRMAN. Cool Water, what is that? That's two or three hundred megawatts, isn't it?

Dr. BALZHISER. Just a little over a hundred megawatts.

The CHAIRMAN. Yes. I thought that was a small one.

Mr. Dowd, have you looked into the question of what we can do with respect to state PUC's and regulatory matters? Or do we have a legal eagle ready to testify on that?

Mr. DOWD. Well, therein lies the rub, Senator. That is the major impediment. We talk about regulatory incentives. The problem is primarily one at the state level.

Understandably, state regulators over the past decade have made every effort to keep electricity rates as low as possible, and we understand that. But it has resulted in retroactive prudence reviews.

It has really resulted, as I mentioned earlier, in the "heads you win, tails I lose" syndrome, which is counterproductive to risk taking.

Now, the Byrd bill contains provisions that are designed to encourage the states. I agree with your earlier remarks. There is a substantial legal question as to whether anything that this Congress does can force state regulatory commissions to do various things.

However, you'll notice that one provision of the Byrd bill suggests that the Department of Energy in deciding which technologies to fund, which projects to fund, may take into account the attitude of the state regulatory commission in that particular state, whether it is one which has developed regulations or incentives that are designed to foster clean coal technology.

This is one thing that the Congress, the Federal Government can do.

The CHAIRMAN. Suppose we said that in order to be eligible for funding, that the state PUC must, in effect, sign the application, and that the signing of that application must contain as a condition that they not come back later and find that that expenditure is non-prudent?

Would that scare too many away, or would that be——

Mr. DOWD. I think that would scare some away. I think it would probably work legally. There is one point of clarification on prudency.

The Byrd bill talks about a rebuttable presumption of prudency. Now, to me what that means is a rebuttable presumption that when the utility decided to install that particular technology, it was acting prudently.

However, if the course of construction of that technology the utility were to botch the job, I don't think anyone would expect that the utility should be protected against imprudent construction.

I think the prudency that we're trying to protect the electric industry with respect to relates to the prudency of their decision-making process to install a particular risky technology.

We don't want the public utility commissions going back and saying, "At the time you made that decision five years ago, it was an imprudent decision.

We'd like to get them on the dotted line on that as early on as we could. I think that the suggestion that you made has considerable merit. I think that might work legally.

The CHAIRMAN. Well, I'd like for you to think through the question of how far we can push on that without poisoning the well. I mean, to me I would think that it is entirely reasonable to ask a state PUC to join into the application, if you're talking about federal dollars.

Now, your point is also a very valid one, that you don't want to protect imprudent actions or unreasonable management of the construction after that decision is made, but certainly with respect to that decision, there shouldn't be any problem, it seems to me, in getting what amounts to a preclearance by the state PUC.

Mr. DOWD. I think that is a very distinct possibility.

The CHAIRMAN. Now, while we're at it, should we throw in a little rule here that says that railroads have got to be reasonable in the rates?

Mr. DOWD. I would leave that one entirely to you, Senator. I think we might muddy the water in clean coal technology. It's not a bad idea, and I'd like to see that happen.

The CHAIRMAN. Well, they're not hauling any of this coal now. It might represent a great new market. I wouldn't know how to word that, but I suspect we could get some help from our friends from—what's that group? CARE?

Mr. DOWD. CURE, C-U-R-E.

We're a member of CURE, and we're very sympathetic with its goals.

The CHAIRMAN. Maybe we'll get CURE to look into whether we should take some action.

Mr. DOWD. That would be another avenue.

The CHAIRMAN. Some of these things are easier to protect before there's a market. After there's a market sometimes they're a little more jealous about what they can charge.

Mr. DOWD. Yes, indeed.

The CHAIRMAN. That's all the questions I have. I don't know whether Senator Ford has any questions of you. But I'll run vote while he's on his way back.

[Recess taken.]

Senator Ford. I apologize for taking so long.

Mr. Wise, I understand that it's your turn. We will proceed then with your testimony. Thank you for being here this morning.

## STATEMENT OF ROBERT L. WISE, PRESIDENT AND CHIEF OPERATING OFFICER, PENNSYLVANIA ELECTRIC CO., ON BEHALF OF THE EDISON ELECTRIC INSTITUTE

Mr. **Wise**. My name is Bob Wise. I am President of the Pennsylvania Electric Company, and Penn. Elec. is one of the operating subsidiaries of the General Public Utilities Corporation.

My company burns about 16 million tons of coal annually, and in fact in 1986 we burned what amounted to about one-fourth of all the coal that was mined in the state of Pennsylvania.

I am testifying today on behalf of the Edison Electric Institute, which I am sure you are aware is the trade association of the investor-owned utility industry. Briefly stated, EEI supports the demonstration and use of a full slate of clean coal technology options. We appreciate very much the support that clean coal technology has received from the Congress in the past and the attention that it continues to receive here today.

Various new technologies are needed for retrofitting or repowering existing plants for environmental control and also for additions to capacity. We also think that some of these technologies will lend themselves well to building future new increments of generating capacity.

The utility industry continues to be an enthusiastic participant in this development effort. However, there are some barriers, some of which have been touched on already this morning, which make it quite difficult for utilities to develop these technologies in a timely manner without government assistance.

Congress had already recognized the technical and financial risks associated with the technology development when it enacted the cost-shared clean coal technology demonstration program. The completion of phases one and two of the current program should result in the demonstration of this wide array of technology options that the utility industry feels that we need.

But even after the technical capabilities of the technology have been demonstrated, potential users are still confronted with a commercially immature technology. With first of a kind plants there is something that a colleague of mine likes to refer to as a period of disbelief, during which any new technology has to be proven in order to gain commercial acceptance.

Utility folks are just plain reluctant to venture large sums of money in pioneering efforts when the potential for return may be slim.

There are additional costs in any new technology, developmental costs, tooling costs. You have to allow for the contingencies that occur during startup and test programs. And frequently, our experience has shown that there may be additional staffing required during startup and test of a new technology.

Several pioneer commercial sized facilities may have to be constructed and operated before the industry will consider that technology to be an acceptable option, with acceptable commercial risks.

Eventually, as these additional units get built and get brought into service, the experience is broadened, there are improvements made and incorporated into the country, and commercial acceptance is gained. It is during this more advanced stage of the development that greater reliability and availability occurs.

It is this help that we need in buying down the risks of these first few of a kind facilities that have the financial assistance in the Administration's initiative and also in Senator Byrd's bill that he described this morning. It is important to note, too, that the uncertainties and costs of new technology development and use, which pose risks for any industry, are significant obstacles in the regulatory environment on which the electric utilities currently operate.

For these reasons, the regulatory proposals in Senator Byrd's bill are particularly important. They provide very significant incentives to help overcome the obstacles in new technology development and use that are very unique to the regulated utility industry.

Senator Byrd's bill recognizes, properly so, that it is the states that have much of the regulatory control and authority which will affect the future success of these technologies. And it includes various provisions designed to encourage their support and partnership in this important effort.

Risks are simply not compatible with today's cost of service ratemaking process which is implemented on a state by state basis. High entrepreneurial rates of return are not available to utilities to compensate for the risks involved. And the timing of any return on what can be a risky and substantial investment may be uncertain, depending on whether and to what extent the state public utility commissions determine that these expenditures were prudent and were in the best interests of the utility's ratepayers.

Also, the potential that currently exists for after the fact prudency review means that utilities can and often will be second guessed by their utility commissions, even after substantial commitments and expenditures have been made. Several years ago, my company chose to pursue the development of an innovative coal cleaning technology instead of a scrubber to meet new source performance standards for one of our new generating units.

Today that unit is operating, it is operating in compliance with the new source performance standards, and with many millions of dollars spent on the development of that technology, the prudence of that investment is today being questioned by the State Office of the Consumer Advocate, in the face of an obviously short term soft coal market in which there is temporarily available on the market some compliance coal at slightly lower cost.

This speaks to some of the second guessing after the fact, years after the fact, prudence questioning that occurs at the state level.

The development and use of new countries may also be impeded by some existing environmental regulations if they are too rigid, if they are applied so inflexibly as to discourage innovation. We have identified some examples in the written testimony which I have submitted and would like to be a part of the record, which we believe merit consideration by the presidential task force on regulatory relief. This task force has been charged with identifying regulatory impediments to the deployment of clean coal technologies.

Finally, the enactment of an acid rain control program could preclude the development of clean coal technologies. With the time constraints that we see in many of the pending acid rain proposals, utilities would have little choice but to try to comply with new regulations by already proven, although costly and inefficient, technologies. And I am talking about flue gas scrubbers.

It would be highly unlikely that new technologies could be developed at a time when billions of dollars would have to be spent on less desirable and more expensive technologies to comply with the mandatory control program.

We agree with earlier statements to the effect that these new technologies have the potential of providing greater long term emission reductions and more cost effectively. They should not be held back by the imposition of an expensive and premature regulatory program.

In summary, Mr. Chairman, the utility industry has already devoted substantial resources to clean coal research and development. With help from the government, we plan to continue our active support for these new technologies. We recognize that Senate Bill 879 and the Administration's initiatives do differ in some respects.

We believe they both contain some very significant and important points. We hope that they can be complementary. We urge the Congress to adopt a program that will continue its support of clean coal.

That is the end of my prepared remarks.

[The prepared statement of Mr. Wise follows:]

STATEMENT BY

ROBERT L. WISE

PRESIDENT AND CHIEF OPERATING OFFICER

PENNSYLVANIA ELECTRIC COMPANY

ON BEHALF OF THE

EDISON ELECTRIC INSTITUTE

before the

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

April 2, 1987

## INTRODUCTION

I am Robert L. Wise, President and Chief Operating Officer of the Pennsylvania Electric Company. Pennsylvania Electric Company (Penelec) is an operating subsidiary of the General Public Utilities Corportation System. Penelec serves about 40% of the land area of Pennsylvania and 533,000 customers. Last year, Penelec stations and those we operate for other companies received 15.8 million tons of bituminous coal purchased for approximately $515 million from the Pennsylvania market, representing 27 percent of the bituminous coal mined in the State.

I am testifying today on behalf of the Edison Electric Institute (EEI), the trade association of the investor-owned electric utility industry. I thank you for this opportunity to come before you to discuss the EEI position on clean coal technologies. That position, briefly stated, is to support the demonstration and use of a full slate of clean coal technology options.

We commend Congress for initiating the industry/government partnership of the current clean coal technology program, and believe that it will accelerate the commercialization of new and promising technologies. We appreciate, too, the leadership many of you have provided in directing and assuring the rapid implementation of this important program.

The clean coal technologies currently under development offer significant potential to expand the use of the nation's most abundant fossil fuel, coal, in a more cost-effective and environmentally acceptable manner than is possible with today's conventional technologies. However, there remain technological, regulatory and financial constraints to the widespread demonstration and deployment of these new technologies which must be addressed.

## NEED FOR CLEAN COAL TECHNOLOGIES

Coal is the backbone of our nation's electricity system, fueling over 56% of current electricity generation. Existing coal-based generating technologies can meet the need for any new capacity and are capable of compliance with increasingly more stringent siting and environmental requirements. But, the costs to consumers could be unnecessarily and unacceptably high.

According to the Electric Power Research Institute (EPRI), it costs three times more today in constant dollars to install a kilowatt of conventional coal-fired generating capacity than in 1967. Further, conventional coal-fired power plants are characterized by economies of scale, meaning they must be relatively large units. They may be too large for the demand increments of many utility systems, and thus too expensive.

More than 30% of the physical cost of a conventional coal-fired plant is for environmental control. Flue gas scrubbers are expensive to install, and costly to operate. They consume up to 8% of a plant's output, use enormous amounts of water, and pose serious reliability problems. Also, current flue gas desulfurization systems address one environmental problem, sulfur dioxide emissions, but create another -- wet scrubber sludge, a by-product that can cause difficult and expensive disposal problems.

The development of clean coal technologies will provide electric utilities with a wide array of alternatives with which to meet the demand for electricity. While no single one of these options will satisfy the widely varying needs and operating conditions of utilities, as a group they offer tremendous potential. Unlike currently available coal-fired generating units with their flue gas desulfurization systems, new clean coal technologies are projected to meet the demand for environmentally acceptable coal use with greater productivity and efficiency. Some offer the advantage of nitrogen oxide control in addition to sulfur dioxide control. They avoid or reduce the sludge problems associated with scrubbers and, in some cases, produce marketable by-products.

Many clean coal technologies also can be constructed rapidly in increments or modules over a wide range of unit sizes, thus better matching capacity to actual demand. By simply shortening the time from the decision to build a plant to commercial operation, there is a greater possibility of matching supply to demand, reducing the risk of using borrowed capital for future generation and reducing consumer costs. Greater fuel flexibility may also reduce the cost of coal.

More specifically, various technologies currently under development have the potential to:

1. Provide moderately efficient retrofit SO2 and NOx controls at far less capital cost than conventional wet flue gas desulfurization (FGD) and postcombustion NOx systems. Clean coal technologies can span the gap between relatively low cost, low emission control represented by coal cleaning and the high cost, high emission controls represented by FGD and SCR (Selective Catalytic Reduction). Examples of these technologies include low NOx burners and dry SO2 controls such as furnace and duct sorbent injection. These control processes are particularly cost-effective at smaller plants with short remaining useful lives and low capacity factors.

2. Provide economical alternatives to repower existing facilities resulting in extended plant life and additional capacity. Combining emissions control with the combustion or conversion process (e.g., fluidized bed, both atmospheric (AFBC) and pressurized (PFBC), or

integrated gasification/combined cycle) results in systems which are less costly, less energy intensive, and more efficient than those removing pollutants from the flue gas.

3. Provide for new generation needs with technologies -- such as fluidized bed and coal gasification -- that are less costly than current pulverized coal plants with FGD systems. These savings are particularly dramatic at smaller scale units (200 to 300 MW) because of the increased opportunity for modularity, reduced construction time, and NOx reduction. These factors will be particularly important as utilities attempt to reduce the risk of using borrowed capital for future generation. Fuel flexibility (e.g., with FBC systems) adds additional cost savings. These new technologies are not burdened by high cost environmental control systems such as scrubbers, which can account for more than 30% of the capital cost of new coal-fired generation.

These new technologies clearly have the potential to permit the use of abundant domestic coal resources in an environmentally acceptable and cost-effective manner. Domestic markets for coal would be maintained and could even be significantly enhanced if these technologies reach widespread commercial use. They also may encourage the export of U.S. developed clean coal technologies and of U.S. coal to fire them.

## COMMITMENT TO CLEAN COAL TECHNOLOGIES

Our nation has made a substantial commitment toward bringing new and cost effective technologies that use coal in an environmentally acceptable manner to the commercial marketplace. A recent Department of Energy report indicates that from 1980-1985 alone, "the U.S. -- through both public and private financing -- spent approximately $3.2 billion on the development of new coal technologies. Of this, the research, development and demonstration of new coal-based technologies to control sulfur dioxide and nitrogen oxide accounted for more than $1.6 billion."

The electric utility industry and others in the private sector have been enthusiastic and vital participants in this effort. EPRI, supported by voluntary contributions from investor-owned, government-owned and cooperatively-owned electric utilities, has invested $700 million in clean coal technologies. Over one third of EPRI's planned budget over the next five years will go to clean coal. In addition, many individual utilities have spent many years and millions of dollars in the conduct of major technology development programs.

The Clean Coal Technology program is making a significant contribution to these efforts. When the Department of Energy solicited a first round of proposals for the program in late 1984, the private sector responded with 176 submissions involving 159 specific projects from sponsors in 29 states. Industry identified more than one dozen technologies that were near commercialization but required large-scale demonstration before the marketplace could put the technology to use.

Congress appropriated nearly $400 million to initiate the clean coal demonstration program in 1985 and in July 1986 the Department of Energy selected nine projects for funding. An additional fourteen were also selected in the event cooperative agreements are not finalized with one or more of the initial nine projects. Contract negotiations are now completed on two of these nine projects, and it is our understanding that DOE expects con tract negotiations on the remaining seven to be completed by June.

During this process, the clean coal program gained additional impetus when President Reagan and Prime Minister Mulroney of Canada endorsed the Report of the Joint Envoys on Acid Rain, Drew Lewis of the United States and William Davis of Canada. Among other things, the envoys recommended a five-year, five-billion-dollar control technology demonstration program to be funded jointly by the federal government and private industry.

Partly in response to the criteria recommended in the Joint Envoys Report, Congress directed the DOE to issue a second solicitation of statements of interest specifically emphasizing technologies suitable for retrofitting, repowering or modernizing existing facilities. Industry strongly continued its commitment to the clean coal technology program by submitting 139 proposals for projects. The total cost of these projects would exceed an estimated $5 billion in value. While statements of interest do not represent actual proposals from the companies, the submissions do indicate the type and scope of projects that could be candidates for later competitive procurements.

One area of concern, however, is the requirement of the current clean coal program that the private sector not only share at least fifty percent of the costs of a demonstration project, but also repay the government's cost-share contribution. Under this DOE repayment requirement, a utility which has subjected its ratepayers to risk for the utility share of a demonstration project is being asked to repay the government if the project succeeds. Clearly, the utility's ratepayers will benefit if the project is successful. However, so will other ratepayers in other utility systems that ultimately deploy these demonstrated technologies. We believe the government's portion for the project should be viewed as that portion of risk-sharing which the government bears on behalf of all ratepayers and taxpayers. The government's contribution should be viewed as a sound leveraged investment, serving as a catalyst to provide incentives stimulating the development and demonstration of technologies beneficial to the entire country.

We strongly urge that such a repayment requirement not be part of any future DOE solicitations. If it is, the incentive for private industry participation will be severely diminished and could adversely affect industry's response.

## CONTINUING BARRIERS TO TECHNOLOGY DEVELOPMENT AND USE - WHY GOVERNMENT ASSISTANCE IS NECESSARY

In enacting the cost-shared clean coal technology demonstration program, Congress recognized that industry runs substantial economic and technical risks in the demonstration of new and innovative control technologies. These risks manifest themselves in all stages of development. Once a technology has been demonstrated, we will have a better understanding of the technical risks and capabilities of that technology. This is the principal objective of the current DOE clean coal demonstration program and the completion of phases I and II should result in the demonstration of a wide array of technology options.

However, even after the technical capabilities of a technology have been demonstrated, potential users are still confronted with a commercially immature technology. Several pioneer, commercial-sized facilities may have to be constructed and operated before industry will consider that technology to be an acceptable option with acceptable commercial risks.

The uncertainties and costs of new technology development and use, which pose significant risks for any industry, are particularly stifling in the regulatory environment in which electric utilities operate. The magnitude of these risks is incompatible with today's cost-based, rate setting practices implemented on a state by state basis.

As regulated public utilities, there is a strong inclination for the industry to confine itself to proven technologies when significant levels of investment are required. High entrepreneurial rates of return simply are not available to compensate for the risks involved. If an untried technology does not meet expectations, individual utilities, including their customers and share holders in varying proportions , could be required by state regulatory utility commissions to shoulder the cost for the effort. Ultimately, this could adversely affect investment in the utility industry, slow the commercialization of these technologies, and result in possible lower electric generating capacity and higher rates for the consuming public.

Even if the technology proves to be successful, the amount and timing of any return on what is a risky and substantial investment will be uncertain, depending upon whether, when, and to what extent public utility commissions treat these expenditures in establishing base revenues. Recent trends in state regulatory policies demonstrate a desire to defer into the future the recovery of investment expenditures through various phase-in plans, capitalizing as many costs as possible and not allowing a current recovery of financing costs during the construction of generating facilities. The result of such practices not only increases the overall cost of the project through increased financing requirements, but weakens the utility's ability to finance new and similar projects.

The development and use of new technologies may also be impeded by some existing environmental regulations. Many are so rigid or are applied so inflexibly as to discourage innovation.

For example, the Environmental Protection Agency (EPA) has found in the context of the 1978 NSPS for utilities that it is important to base utility emission standards on a 30-day averaging time, in light of the variability in fuel characteristics and control equipment performance. EPA, however, has been reluctant to clarify that emission standards provided for under the 1971 NSPS and state implementation plans also reflect 30-day averaging. Such clarification is crucial if new technologies are to be capable of complying with emission standards, and therefore will be critical to the success of the clean coal technology program.

Also, since the clean coal technology program by definition addresses technologies that have not been demonstrated, sources involved in demonstration projects may experience problems with reliable pollution control equipment operation. EPA should make clear that, as long as the public health-based air quality standards during the demonstration period are met, sources involved in such demonstration projects will be afforded flexibility with respect to compliance with emission standards. Among other things, EPA should move forward with emission trading and expanded bubbles to encourage these innovative technologies.

## PROPOSED ACID RAIN LEGISLATION

Clean coal technology development and demonstration is supported by the electric utility industry as a productive means of achieving superior environmental control in a cost-effective manner. We do not believe that an acid rain control program, such as those embodied in pending proposals, reflects this same policy. Rather, a regulatory program like the ones being advocated in pending legislation would preclude the development and deployment of clean coal technologies as utilities would have little choice but to try to comply with new regulations by using already proven, though costly and inefficient, emission control equipment. Billions of dollars would have to be spent on current technology, making it highly unlikely that new technologies could be developed concurrently.

Though some pending acid rain proposals would impose controls in two phases, they do not solve the problem. Each electric utility will develop a specific plan of compliance patterned to the needs and abilities of that utility. It is, however, unlikely that a utility would choose a course of action whereby an individual unit would be controlled twice -- once though the switching of fuels, and later through the retrofitting of a clean coal technology that was not commercially available when the control program was enacted. Rather, compliance plans are likely to be fashioned so that affected units are controlled only once, bypassing the less stringent interim requirements.

Further, while some of these technologies may be available for commercial application at or about the time emission reductions would be required, it is simply not true that a utility can plan now to use an unproven technology. Few, if any, would risk the possibility of non-compliance through reliance upon an unproven technology. Rather, a utility would plan to comply by using whatever means were available when the requirement was enacted.

As Congress continues examination of acid rain control legislation, EEI urges that the impact upon the clean coal initiative be carefully considered. The demonstration and widespread use of these new technologies could provide greater long-term emissions reductions more cost effectively, and should not be stymied or prevented by the imposition of a costly and premature regulatory program that would dictate reliance upon current technology.

## PENDING PROPOSALS

On March 18, President Reagan announced his commitment to the expenditure of a total of $2.5 billion over five years for innovative control technologies, recommended by the Report of the Joint Envoys on Acid Rain. The Department of Energy has indicated that this will be initiated with a request for appropriation of $850 million over the next two fiscal years.

We strongly support the President's commitment to the development of clean coal technologies and applaud in particular his proposal to commit a very significant amount of initial funding to a multi-year program. Because this is a partnership program to which private sector project sponsors must commit significant private resources, multi-year funding is very important to provide some assurance that federal funds will be available to fully fund the government share.

The President also directed the Vice President to have the Presidential Task Force on Regulatory Relief to identify regulatory impediments to the deployment of clean coal technologies. The findings and results of the Task Force review are to be reported in six months, along with any recommendations for changes in existing regulations. This, too, is a very positive and badly needed initiative, and we hope to have an opportunity to work with the Task Force as they develop their report. The ratemaking and environmental barriers just discussed are among those which should be examined.

We applaud too, the Clean Coal Technology Deployment Act introduced earlier this week by Senate Majority Leader Robert Byrd. Senator Byrd has been a strong and effective advocate of the clean coal program, and this initiative would help to accelerate the commercial use of these technologies once they have been technically demonstrated.

Specifically, S.879 would establish a Clean Coal Technology Deployment Assistance Program to fund grants in aid of construction or operation for up to 50% of clean coal project expenditures to a limited number of commercial-sized projects. The legislation also would encourage the deployment of successfully demonstrated clean coal technologies by providing for specified incentives to be adopted as part of wholesale rate proceedings before the Federal Energy Regulatory Commission (FERC). These provisions are particularly important in helping to overcome the obstacles to new technology development and use that are unique to a regulated industry. Further, it would encourage the states to adopt the same regulatory incentives provided at the federal level, and to coordinate and expedite their permitting and siting procedures. Since it is the states that have much of the regulatory authority which will affect the future success of the clean coal program, their cooperation and participation is critical.

## CONCLUSION

The federal clean coal technology program is vital to this nation in providing continued cost effective, environmentally acceptable use of our most abundant fossil fuel for the purpose of producing electricity. These technologies hold significant promise of economic and environmental benefits through their application to both new and existing facilities.

The clean coal technology program initiated by Congress represents a unique partnership between private industry and federal government. The utility industry already has devoted substantial resources to clean coal research and development and, with crucial help from the government, plans to continue its active involvement in support of these promising technologies.

Senator FORD. I guess I could ask you this question in writing, but I need the answer. Maybe all of you can come together on it. When will clean coal technologies be ready under the present circumstances? When can we expect these clean coal technologies to be available where you can use them and not be questioned?

Mr. WISE. Well, some of the technologies are at various stages of development today or demonstration today. Some of the retrofit technologies I think will take an overall shorter time to come to fruition. Maybe in as little as five years, some of those technologies will be becoming mature. Some of the other technologies may take many more years.

The innovative coal cleaning process that I talked about that we have put in at Homer City, we started that back in 1973–74. We continue today to make improvements in it. We continue to mature that technology.

So it is an ongoing thing and it is something that can take over ten years, well over ten years. The important thing is to get started, commit the funds, keep the effort going, and keep the pressure on.

Senator FORD. Would either of the other gentlemen there like to agree or disagree or take a little different approach?

Mr. DOWD. Well, Senator, I can speak in terms of the major program that we have under way. This is our pressurized fluidized bed combustion project, which is going into demonstration with federal and state financial assistance.

Hopefully, construction will begin this year. The agreement has been signed with DOE. We expect the demonstration project, about 80 megawatts, to be completed in 1993. And if it proves out in the way that we expect it will, it would then be ready for deployment by the industry on a basis that perhaps would be assisted under Senator Byrd's concept of deployment.

And that would be perhaps another five years. So you are talking about ten years for that technology to reach a hoped-for commercial stage, a minimum of ten years from today. And we have already gone through many years in the past of developing it to the stage that it is at now and working with the Department of Energy and the state of Ohio to get the necessary funding.

Senator FORD. Mr. Dowd, how does that compare with your atmospheric fluidized bed combustion?

Mr. DOWD. Ours is pressurized, pressurized.

Senator FORD. Atmospheric is the one that is going on at Shawnee?

Mr. DOWD. That is correct.

Senator FORD. And that is within a year of being ready to start, close to a year of being ready to start the demonstration portion of it. As I understand that one—I do not know how that compares to your pressurized situation—the A.F.B.C. is supposed to be about 160 megawatts, I think, and use somewhere in the neighborhood of 600,000 tons of coal a year.

So we are beginning to move, I guess.

Mr. DOWD. I might mention again, my familiarity is in large part confined to our project. But in terms of its environmental benefits on $NO_x$ emissions, the present new source standard is .6 pounds.

We would expect our project to do 0.3 pounds, substantially below the new source standard.

And on $SO_2$ removal, we would hope for a 95 percent removal, which compares favorably with the most advanced scrubbers today.

And furthermore, we hope to be able to achieve this at ten percent less cost than for a more conventional facility. And finally, we would avoid the scrubber sludge disposal problem with this technology.

So there are many merits to this and to comparable technologies, atmospheric fluidized bed as well. They are well worth waiting for, we think.

Senator **Ford**. Doctor, do you have any comment that you would like to add?

Dr. **Balzhiser**. I would make this observation. You referred to the TVA project at 160 megawatts. We expect that when that plant goes operational we are going to continue to learn things about the feed mechanisms for the system, about the tube configurations.

And I say that based on the experience that we have had on utility scale at Northern States Power. We are already operating there at the 100 megawatt scale there the first retrofit of a boiler. It is in their Black Dog Unit. We have experienced the kind of failures you expect to have. The reason you build them is to learn.

And I am sure that the state of learning is still rather high. We can expect it to go on, I think, in fluidized combustion for at least five years. And I think, while the kind of funding we are talking about could accelerate it, I think realistically it will probably be ten years before the typical utility in this country would go out and order this kind of technology.

Senator **Ford**. Let me ask one final question and I will turn it over to Senator Johnston. We have another vote on the floor, and this is going to be going on all day and I do not want to prolong this hearing any longer than I have to.

But how will the clean coal technologies in their timing be ready compared to our projected needs for electricity? We are talking about the clean coal technologies, and yet we are looking at power need. Senator Johnston is very emphatic—and I agree with him—that we are on the eve of a shortage. And how will these technologies compare to the projected needs?

Does anybody wish to start? Mr. Wise, and then we will go to the doctor and then Mr. Dowd.

Mr. **Wise**. Let me comment first that in my service territory we see these new technologies being compatible with our load growth, which is currently rather flat. We expect that the combination of reduced load growth rates and also the reluctance of utilities to take large financial risks on building extremely large baseload units, as we did over the last couple of decades, will lead utilities to want to install new capacity in smaller increments—100 megawatt, 200 megawatt increments.

We believe that these new technologies will enable us to comply with new source performance standards at a lower cost, a lower unit cost installed for 100 megawatt modular type construction, and lend themselves very well to that concept.

As far as the timing on when they will be available, it is difficult to predict what load growth will do. If load growth takes off soon, then we are going to be hard pressed to keep up with that growth, although we will have to. I think that the difficulty in predicting what will happen to load growth has been demonstrated over the last decade, when many large stations were built and some utilities ended up with excess capacity because they missed their bet to some degree on what was going to happen with their load growth.

Dr. BALZHISER. Mr. Chairman, I think today one of the more popular approaches being pursued by utilities facing the need for additional expansion or concerned about that—and I am sure this is good news to Senator Johnston—is looking at combustion turbines or combined cycles, whêre they can install them in smaller pieces, start up with gas, but with the site laid out so that if and when gas either becomes too expensive or unavailable they can switch to the gasified coal as a source of fuel.

And I think that is a popular way right now for utilities to look at meeting future needs.

Senator FORD. Mr. Dowd?

Mr. DOWD. Senator, I am not sure that this is responsive to your question, but if we view the clean coal technologies program as something that the nation would embark on in lieu of acid rain control legislation, then clean coal technologies would permit us to go forward with the retrofitting of existing plants that we might wish to keep in service longer or the construction of new plants with new source performance technologies of an improved variety, whereas acid rain control legislation, because it would mandate the retrofitting of scrubbers on many, many power plants throughout the United States, would not only freeze the technology for a long period of time at that unsatisfactory level, but it would require us to continue to live with our existing older plants for a much longer period of time than we would otherwise have done, because we would have sunk so much money into the retrofit of scrubbers on plants that are 30, 35 years old, that we would just be constrained to keep them in operation much longer than we otherwise would and not replace them with new power plants.

So I think the clean coal technologies program affords the nation with a much higher degree of flexibility in meeting future energy demands.

Senator FORD. Thank you very much.

Senator Johnston.

The CHAIRMAN. Senator Ford, thank you.

I think Mr. Dowd's answer there needs to be a lot more widely circulated, because I think that is the most cogent argument against premature deployment of any acid rain legislation. And that is that it expensively locks you into obsolete technologies which do not get the job done and locks those technologies into existing plants because you have that big capital investment and you have got to keep the plants a long time, rather than to modernize.

And we need to go forward and modernize these things.

All right, let me ask this. The technology that we will probably use is very much a variation on the theme of Coldwater—Coolwater? Is it Coldwater or Coolwater?

Dr. BALZHISER. Coolwater.

The CHAIRMAN. Coolwater.

Is that right?

Dr. **Balzhiser**. That is one of what I call the super-clean technologies.

The **Chairman**. We are talking about combined cycle?

Dr. **Balzhiser**. Yes. Coolwater is a gasification combined cycle option, and I think there are a series of generic options there.

The other family is the fluidized combustion processes, both atmospheric and pressurized.

The **Chairman**. Now, basically the technologies are known. It is not like we are going to invent some brand new machine. These technologies are fairly well known. It is sort of an engineering problem of how do you make each little step, each little widget, more efficient and more cost effective, more efficient in both cleaning up the $SO_2$ and more cost effective.

Is that correct?

Dr. **Balzhiser**. It is correct. And I think it may help to give you a better picture of the challenges that the utilities face if I were to characterize it this way. Utilities over the years have developed expertise in combustion, in burning coal, in boiler technology. The kind of technologies we are talking about, gasification or fluidized bed, are a lot more similar to technologies used in the chemical or petroleum industry, what we call process technologies.

And that is necessary if you want to go about getting out the sulphur and the nitrogen, rather than putting them up the stack. Now, that is quite a different technology for the utility industry to operate.

They made a transition. They have learned to operate nuclear technology. There are a lot of differences between raising steam in reactors and raising it in boilers. Now we are talking about technology that is really more chemical or petroleum-oriented.

The **Chairman**. Which is based on heat and pressure and reforming the molecules?

Dr. **Balzhiser**. That is correct, yes, sir.

The **Chairman**. It is in effect very much like a refinery?

Dr. **Balzhiser**. It has been called a coal refinery. The Coolwater technology has been referred to as a coal refinery. And indeed, it is Texaco technology that we have wed with the rotating machinery that is the domain of the utilities.

The Chairman. What do you figure—if you were going to redo Coolwater today and you did not put on the extra whistles and bells, what do you think you could bring that on for per kilowatt hour?

Dr. **Balzhiser**. The next plant?

The **Chairman**. Yes.

Dr. **Balzhiser**. I would guess the next plant we could probably reduce by five percent—I am guessing and I will get you a better answer for this. For example, we would not put in the next plant the biggest vessel that is in there, the vessel that gives the plant its highest profile. We do not think that the output, what we have gained from that, is worth the cost. That is one of the things that we have learned.

The **Chairman**. Just give me a ballpark estimate of what you think you could build it for per kilowatt hour?

Dr. **Balzhiser**. Let me get that answer for you. I hesitate to give it to you without going back and checking.

The CHAIRMAN. SoCal Ed says 5.5 cents per kilowatt-hour, I am advised.

Dr. BALZHISER. 5.5 cents for the electricity cost. They are a better judge of that than I would be. I would go with that number if that is what they said.

The CHAIRMAN. If we can do that——

Dr. BALZHISER. It sounds pretty good to me.

The CHAIRMAN. If they are right, and I know they are very excited about the technology and about this possibility. But I mean, if you can do it for 5.5 cents, it seems to me like everybody ought to do it.

Senator FORD. We have to be careful here in our judgment, because we are talking about a 100, 250 megawatts, and I think the figure you received was much larger, like 1,000, 1,500.

Dr. BALZHISER. Our assessment is that three to four plants can get us down to capital costs and with operating efficiencies that will equal or exceed what you would do with conventional technology.

We do not see this as offering gigantic breakthroughs. We are trying to find a better way to meet both the operating and economic demands of the utilities, as well as the environmental concerns of society.

The CHAIRMAN. Well, it looks to me like we are virtually there now, based on technology, and we just need to smooth out a few of these wrinkles.

Dr. BALZHISER. It is that last barrier, getting over those last barriers to commercial acceptance. That is exactly what we are trying to do.

The CHAIRMAN. Well, we need to get this message out, Senator Ford, to the acid rain crowd, that if they will help us do this clean coal that is the solution to this thing, rather than all this retrofit.

Senator FORD. I agree with the Senator.

We are hit again with a vote and we are pressed for time. I am going to recess this hearing until April the 9th, and we will continue the hearing; and also leave this record open for questions until April the 22nd for this hearing today, which will be after our Easter recess. We hope that the questions that we have not covered here today will be mailed for you to answer later, doctor, you would go ahead and send those in. There may be other questions in writing that will come in from members, because you really whetted our appetite here this morning as it relates to what we should or should not do.

I thank you all, Senator Byrd, Secretary Evans, and you three gentlemen, for being here this morning, and look forward to working with you in the future.

This hearing is recessed.

[Whereupon, at 11:20 a.m., the subcommittee was recessed, to reconvene Thursday, April 9, 1987.]

# CLEAN COAL TECHNOLOGY PROGRAM

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THURSDAY, APRIL 9, 1987

U.S. Senate,
Subcommittee on Energy Research and Development,
Committee on Energy and Natural Resources,
*Washington, DC.*

The subcommittee met, pursuant to notice, at 9:35 a.m. in room SD-366, Dirksen Senate Office Building, Hon. Wendell H. Ford, presiding.

## OPENING STATEMENT OF HON. WENDELL H. FORD, A U.S. SENATOR FROM THE STATE OF KENTUCKY

Senator Ford. Good morning, ladies and gentlemen. It is a pleasure to see all those bright and shining faces out there this morning, and this is the second in a set of hearings on clean coal technology.

Last Thursday, we heard about some promising clean coal technologies. We also heard some suggestions on how to break down some of the regulatory barriers preventing deployment. We expect to hear more in the way of support for these technologies from our witnesses today.

Clean coal is an important part of our nation's energy policy. It is important, if not imperative, for the U.S. to develop and expand our slate of clean coal technologies. These technologies can achieve significant reductions in the emissions of both sulfur dioxide and nitrogen oxides. Both are involved in the controversy over acid rain.

Clean coal technologies reduce emissions while using a broad range of U.S. coals. Also, they may provide additional benefits through retrofitting and repowering, as a way of meeting the increase in demand for electricity in a cost effective and environmentally sound manner.

Emissions reductions are a popular topic these days. The Canadian Prime Minister and our President met this past weekend in Ottawa. Among the topics discussed was acid rain.

I understand that the Prime Minister pressed our President for a bilateral treaty on acid rain controls. The President, it seems, agreed to consider an international accord, which he says builds upon the agreements for limiting pollution in international waters. This follows closely on the heels of his recent announcement to proceed with a three-pronged approach to meeting the recommendations of the Joint Envoys on Acid Rain.

The President's program included a $2.5 billion, five year research program, the establishment of an advisory board, and a report by a Presidential task force. We are anxious to hear from our Administration witness, Secretary Wampler, about the details of implementing the development initiative and also what this new international accord really means.

Let me conclude by saying that I believe the environmental costs of acid rain are large, but the causes of this damage are not yet known.

Emission controls may not be the way to solve the problem. Emission controls are costly and can be very disruptive to our economy.

Developing clean coal technologies, on the other hand, will serve a variety of energy policy needs and will result in cleaner burning power plants in the future. Further development and commercialization of clean coal technologies will assure that we rely upon our nation's most abundant energy resource, coal, which will help us meet the projected electricity demand for the future, and advances our environmental progress, while contributing to the spirit of cooperation with our international neighbors.

So with that opening statement, we are very pleased to have Secretary Wampler of the Fossil Energy Programs, U.S. Department of Energy with us today. Mr. Wampler, you may proceed—oh, excuse me.

I am sorry. Senator Hecht, I was so anxious to get started because I was five minutes late, I was driving right on.

Senator HECHT. You are the Chairman, so you are never late. We just came up early.

Senator FORD. I will use that the next time. Thank you.

## STATEMENT OF HON. CHIC HECHT, A U.S. SENATOR FROM THE STATE OF NEVADA

Senator HECHT. Just briefly, I think energy is the No. 1 crisis facing us in the future. When our distinguished Secretary Hodel came before us and said he would not be surprised to see gas lines by 1990, we better starting focusing more on energy.

And we have oil and gas, coal and nuclear. Certainly our oil and gas is running out, and nuclear has a bad connotation in the mind. So I think we all should focus on coal more.

And I thank the distinguished Chairman for holding these hearings. Thank you.

Senator FORD. Thank you, Senator.

I will insert in the record at this point a statement from Senator McClure.

[The prepared statement of Senator McClure follows:]

OPENING STATEMENT
SENATOR JAMES A. McCLURE
RANKING MINORITY MEMBER
COMMITTEE ON ENERGY AND NATURAL RESOURCES
APRIL 9, 1987 (9:30 A.M.)

## DOE CLEAN COAL TECHNOLOGY PROGRAM

As the Chairman is aware, the DOE Clean Coal Technology program was established by the Appropriations Committee, not the Energy and Natural Resources Committee. The objective of the program is very clear -- the construction and operation of clean coal technology projects to demonstrate their feasibility for future commercial applications. This is a broad objective, not limited to acid rain control. And that objective is being achieved.

Last year the full Committee held extensive hearings on the relationship between timetables being proposed for mitigation of acid rain and when results can be expected from the DOE Clean Coal Technology program.

My concern was the apparent dichotomy between the compliance schedules in proposed acid rain control legislation and the projected timetables for development of new clean coal technologies. My belief then, as it is now, is that it is in the national interest that the interrelationship between energy and environmental policies be appropriately reflected in any strategies for the mitigation of acid rain.

But as I mentioned, the objective of the DOE Clean Coal Technology program was broader than the mitigation of acid rain. Therefore, I am disturbed, first, by recent efforts to convert the program into an acid rain control program and, second, by proposals to use Federal funds to deploy clean coal technologies before they have been fully demonstrated.

For example, in response, in part, to pressures from the Canadian government, the President has announced his intention to commit $2.5 billion over the next five years to the Acid Rain Innovative Control

TECHNOLOGY PROGRAM. HOW THIS PROGRAM DIFFERS FROM THE DOE CLEAN COAL TECHNOLOGY PROGRAM IS UNCLEAR.

I HAVE FOUR BASIC CONCERNS. FIRST, WHAT IS THE APPROPRIATENESS OF USING FEDERAL FUNDS TO UNDERWRITE INDUSTRY EFFORTS TO COMPLY WITH STATE AND FEDERAL ENVIRONMENTAL LAWS. SECOND, IF WE MOVE TOO FAST WILL THE EFFECT BE TO FREEZE AND DEPLOY KNOWN TECHNOLOGIES, SUCH AS SCRUBBERS, RATHER THAN CLEAN COAL TECHNOLOGIES. I SAY THIS RECOGNIZING THAT THERE ARE THOSE WHO ARE INTERESTED IN IMMEDIATE CONTROL RESULTS REGARDLESS OF COST, RATHER THAN FUTURE RESULTS, EVEN IF ACHIEVED IN A MORE COST EFFECTIVE MANNER.

THIRD, WHAT IS GOING TO BE THE FEDERAL SOURCE OF FUNDS FOR SUCH DEPLOYMENT. RIGHT NOW THE ADMINISTRATION PROPOSES IN FISCAL YEAR 1988 TO FUND ITS ACID RAIN INNOVATIVE CONTROL TECHNOLOGY PROGRAM AT THE EXPENSE OF ONGOING FEDERAL PROGRAMS IN THE DEPARTMENT OF AGRICULTURE, THE DEPARTMENT OF ENERGY AND THE ENVIRONMENTAL PROTECTION AGENCY.

AND, FOURTH, WHAT EFFECT IS A PROMISE OF FUTURE FEDERAL FUNDING GOING TO HAVE ON PRIVATE INVESTMENTS THAT WOULD OTHERWISE OCCUR. THE PROMISE ALONE MAY VERY WELL STIFLE SUCH PRIVATE INVESTMENTS.

AS THE CHARIMAN KNOWS, I HAVE SUPPORTED THE DOE CLEAN COAL TECHNOLOGY PROGRAM SINCE ITS INCEPTION. IT NOW APPEARS THAT IT IS PROPOSED TO RESTRUCTURE THE PROGRAM TO MEET THE NARROWER OBJECTIVE OF ACID RAIN CONTROL.

BEFORE WE PROCEED FURTHER DOWN THIS NEW ROAD, WE NEED TO UNDERSTAND THE ISSUES I HAVE RAISED. IT THEREFORE IS APPROPRIATE, AT THIS TIME, FOR THE ENERGY AND NATURAL RESOURCES COMMITTEE TO CONDUCT THESE OVERSIGHT HEARINGS AS WELL AS SCHEDULED HEARINGS ON PROPOSED LEGISLATION.

I LOOK FORWARD TO WORKING WITH YOU IN THIS EFFORT.

Senator FORD. Secretary Wampler.

## STATEMENT OF J. ALLEN WAMPLER, ASSISTANT SECRETARY FOR FOSSIL ENERGY, DEPARTMENT OF ENERGY, ACCOMPANIED BY DONALD BAUER, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR FOSSIL ENERGY; AND JACK SIEGEL, DEPUTY ASSISTANT SECRETARY FOR COAL TECHNOLOGY

Mr. WAMPLER. Thank you, Mr. Chairman.

Mr. Chairman, members of the Subcommittee; I have with me at the table today Mr. Donald Bauer, Principal Deputy Assistant Secretary for Fossil Energy——

Senator FORD. Pull that microphone a little closer.

Mr. WAMPLER [continuing]. And Mr. Jack Siegel, Deputy Assistant Secretary for Coal Technology.

I have submitted a formal statement for the record, Mr. Chairman. Recognizing that the Subcommittee has a lot to cover today in a limited amount of time, I would like to say only a few brief words to summarize the ongoing clean coal initiative, and the President's recent commitment to expand the effort in line with the Special Envoys' Report on Acid Rain.

The President's announcement on March 18th that he would seek the full amount of the government's share of funding recommended by the Special Envoys fulfills a commitment made last year to Prime Minister Mulroney.

But in addition to addressing a pressing national concern of many Canadians, the President's initiative will also return significant benefits to this nation—not only in terms of cleaner air and the increased use of our most abundant energy resource, but also in the form of enhanced technological leadership and the potential for improved international trade.

We are in the final stages of preparing the necessary amendment to our Fiscal Year 1988 budget request, Mr. Chairman, and we recognize the Committee's requirements for quick action. I can assure you that the Secretary has placed the rapid implementation of the President's program as one of his highest personal priorities, and those of us in the Office of Fossil Energy are responding in like fashion.

In general terms, the President's pledge is to seek funding in the amount of $500 million a year for five years. In Fiscal Year 1988, the $500 million request will be made up of $350 million to be drawn from the remaining funds in the Clean Coal Technology Reserve Fund and $150 million that Congress had previously scheduled for appropriation in Fiscal Year 1988 for the first round of clean coal projects.

We plan to continue negotiations and award of agreements to the nine firms that were selected in the first round of the Clean Coal Technology Program.

While we recognize that this subcommittee, and the Congress as a whole, established the initial program under much broader guidelines than the President proposes to use in subsequent rounds, several first round projects, in retrospect, meet the more focused criteria of the Special Envoys.

Five of the projects employ technologies that, either as demonstrations or in commercial application, fit the Lewis-Davis criteria. That is, they can be used as retrofits on high sulfur coal burning facilities in a cost effective manner.

Therefore, we believe some credit should be given in Fiscal Year 1988 for the anticipated federal share in those projects. That amount is approximately $150 million, which also is to be the third and final increment of the first round funding scheduled to become available in Fiscal Year 1988.

To meet the President's commitment of $500 million a year in Fiscal Year 1988, we will be asking for new appropriations of $350 million, drawing, as I said, from the funds remaining in the Clean Coal Technology Reserve Fund. We will also be asking for an advance appropriation of proposed funding of $500 million for Fiscal Year 1989, in order to combine both Fiscal Year 1988 and Fiscal Year 1989 funds for use in a single competitive solicitation of $850 million.

Our plan is to issue this solicitation by the end of this calendar year, pending Congressional approval, and to select projects by the spring of next year. And to ensure that industry has confidence that the Administration is prepared to provide its share of financing, we will also be asking for the remainder of the $2.5 billion to be made available in the form of advance appropriations.

We believe this will demonstrate our commitment to this program and to the Lewis-Davis report. The Administration intends to submit an annual budget request for the Clean Coal Program as part of the President's yearly budget submission to Congress. This will allow for full Congressional review and input into the future course of the Program.

We will also provide to the Congress in the near future the Civilian Program Authorization Bill for Fiscal Year 1988, which will seek authorization of funding for this Program. We envision multiple solicitations between 1988 and 1992, each one drawing on the experience of the past, combined with guidance from an advisory panel to be established by the Secretary and direction from Congress.

I might say at this point that the Secretary has been very specific in directing us to fashion an evolving, Innovative Clean Coal Program that: one, can be carried out in full cooperation with Congress; and two, which is flexible enough to incorporate new technologies as they emerge over the next five years.

That completes my opening remarks, Mr. Chairman. I will be pleased to answer any questions.

[The prepared statement of Mr. Wampler follows:]

# THE NATIONAL CLEAN COAL TECHNOLOGY PROGRAM

Testimony by
J. ALLEN WAMPLER
Assistant Secretary for Fossil Energy
U.S. Department of Energy

before the

Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources
U.S. Senate

April 9, 1987

Mr. Chairman and Members of the Committee:

The term "clean coal technology" has become an increasingly important part of our energy vocabulary. It has come to signify a new generation of highly efficient, environmentally clean coal-based technologies -- concepts that will permit this nation to increase its use of coal while continuing the excellent progress made in the last decade to improve the quality of our air.

I am pleased to have the opportunity today to describe the Administration's efforts to assist industry in moving these technologies nearer to the threshold of commercial acceptance and application. My testimony this morning will focus on both the ongoing Department of Energy Clean Coal Technology program as well as the President's recently announced initiative to expand this effort in accordance with the 1986 report of the Special Envoys on Acid Rain.

I have also included descriptions of the environmental and performance benefits of these new coal-based technologies -- benefits that were only projected a decade or so ago but which today are being demonstrated through actual, commercial-scale, functioning hardware.

In addition to describing the budgetary aspects of the federal Clean Coal Technology program, Mr. Chairman, I hope my testimony will provide justification for why the Department of Energy believes the development and deployment of advanced clean coal technologies represents a preferred course of national response to such issues as acid rain as well as the future energy security of our Nation.

## The National Clean Coal Program

Today's expanding slate of clean coal technologies has emerged from a decade of smaller-scale development by both government and industry. Many concepts now crossing the commercial threshold originated in the aftermath of the 1973 OPEC oil embargo. With the Nation's economy shaken by the sharp rise in oil prices and sudden concern over the vulnerability of imports, the U.S. coal research program was driven principally by a goal of displacing liquid and gaseous fuels.

In the 1980s, the perception of primary R&D needs has been expanded. With increased attention focusing on the issue of "acid rain" and other air pollutants, the scope of the national coal research program now includes high-priority efforts to develop new technologies that can control $SO_2$ and NOx.

Many of the technologies under development in the 1970s for other purposes also have the potential to be attractive alternatives to conventional pollution controls. Thus, the scientific and engineering groundwork laid in the 1970s and early 1980s now forms the technological basis for developing, demonstrating and deploying the new generation of clean coal technologies. Most importantly, this technological evolution is taking place not only through federally sponsored efforts but also through initiatives pursued by State governments and by the private sector.

All of these efforts -- both public and private -- combine to make up the "National Clean Coal Program", and all should be included when discussing America's commitment to increasing the use of coal in concert with achieving a higher quality environment.

## The Federal Program - Clean Coal Technology Round #1

On December 19, 1985, Pub. L. No. 99-190, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1986, and for Other Purposes," was signed into law. This Act, among other things, provided funds to conduct cost-shared clean coal technology projects for the construction and operation of facilities that would demonstrate the feasibility of future commercial applications of such technology.

The Act further required that DOE issue a "general request for proposals" for the Clean Coal Technology Program within 60 days of the date of enactment (i.e., by February 17, 1986), provided 60 days from issuance of that request for the proposals to be submitted (i.e., by April 18, 1986), and required the selection of projects for negotiation no later than August 1, 1986. The Department met the Congressional requirements in issuing a Program Opportunity Notice soliciting proposals and receiving and evaluating the responses.

The Act made available $397.6 million for this program, as follows: $99.4 million in fiscal year 1986, $149.1 million in fiscal year 1987, and $149.1 million in fiscal year 1988.

Of these monies, $1.2 million was transferred in FY 1986 to the Small Business and Innovative Research Program (SBIR) as required by the Small Business Innovative Development Act of 1982 (Pub. L. No. 97-219) and is unavailable to the Clean Coal Technology Program. This transfer left available funding of $98.2 million for FY 1986 and total current availability for the first solicitation of $396.4 million.

In addition, $3.7 million will be transferred to the SBIR program for FY 1987 and FY 1988. Also, $25 million has been held in reserve to cover the cost of project overruns in the event that the Government agrees to share such costs. Finally, $5.5 million has been set aside for contracting, travel, and ancillary costs incurred by the DOE in implementing the Clean Coal Technology Program. The remaining $362.2 million is currently available for award to eligible clean coal projects.

By Congressional direction, the first round of competition for federal cost-sharing was open to all market applications of clean coal technology that apply to any segment of the United States coal resource base. The competition encompassed both "new" and "retrofit" applications.

The final Program Opportunity Notice was issued on February 17, 1986. In response to the public comments received regarding a prior, publicly-distributed draft notice, and also as a result of continued review by the Energy Department's Source Evaluation Board, several improvements were made in the final solicitation compared to the original draft. Also, an amendment to the Program Opportunity Notice was issued on February 24, 1986, which revised sections relating to revenue sharing.

The Environmental Protection Agency (EPA) was given a copy of the draft solicitation to review, and the agency provided comments to DOE. Further, EPA personnel served as advisors to DOE during evaluations; the EPA advisor provided comments on the environmental aspects of all proposals and an EPA representative served as a member of the evaluation team for proposals where the agency had expertise (those involving flue gas desulfurization and the Limestone Injection Multistage Burner technology).

After considering the evaluation criteria, program policy factors, and the National Environmental Policy Act (NEPA) strategy as stated in the solicitation, the Energy Department selected proposals from the following offerors, listed in alphabetical order, as best furthering the goals and objectives of the Program Opportunity Notice:

American Electric Power Service Corporation
Babcock & Wilcox
Coal Tech Corp.
Energy & Environmental Research Corporation
Energy International, Incorporated
General Electric Company
Ohio Ontario Clean Fuels, Incorporated
The M.W. Kellogg Company
Weirton Steel Corporation

In the event that a cooperative agreement could not be awarded to any of the selected proposers, the Department identified a second list of candidate proposers:

City of Tallahassee
Colorado - UTE Electric Association, Inc.
Combustion Engineering, Inc.
Consolidation Coal Company and Foster Wheeler
  Power Systems, Inc.
McDonnell Douglas Energy Systems, Inc.
Minnesota Department of Natural Resources
Southwestern Public Service Company
Tennessee Valley Authority (2 proposals)
TRW, Inc.
United Coal Company
Western Energy Company
Westinghouse Electric Corporation
Wisconsin Electric Power Company (subsequently withdrawn)

If, at the conclusion of negotiations with the originally selected proposers, agreements cannot be reached with any firm, the evaluation criteria and program policy factors will be applied to the second list to select additional project(s).

On August 21, 1986, a "Comprehensive Report to Congress On Proposals Received in Response to the Clean Coal Technology Program Opportunity Notice" was submitted to Congress. That report outlined the solicitation process implemented by DOE for receiving the first round of Clean Coal Technology proposals, summarized the proposals received, provided information on the technologies that were the focus of the program, and reviewed special issues and topics related to the solicitation.

Current Status -- On March 20, 1987, immediately following the expiration of the required 30-day Congressional review, the Energy Department signed the first two joint government-industry clean coal technology cooperative agreements. The agreements were signed with American Electric Power Service Corp. (AEP), of Columbus, OH, acting on behalf of the Ohio Power Company, and with Coal Tech Corp. of Merion, PA. The two companies were the first of the nine firms selected in Round #1 to complete negotiations with the government.

Under the agreements, AEP will design and install an advanced "pressurized fluidized bed combustor" at the currently idle Tidd Facility on the Ohio River near Brilliant, OH. The pressurized fluidized bed technology is intended to remove 90 to 95 percent of sulfur dioxide from coal combustion gases before they leave the boiler. Nitrogen emissions are also reduced due to the technology's lower combustion temperatures compared to a conventional boiler. In commercial application, pressurized fluidized bed combustion/combined cycle technology could increase a conventional power plant's electric output by 40-50 percent.

The AEP project is expected to cost $167.5 million with the government's share capped at $60.2 million. Construction will begin by the end of this year with the three year operating phase starting in early 1990.

Coal Tech will replace a standard oil burner at the Keeler Boiler Manufacturing Company plant in Williamsport, PA, with a newly-designed advanced "slag-rejecting" coal combustor. The innovative combustor would be attached to the outside of the boiler and would remove ash and other impurities before they can build up as energy-robbing deposits. Sulfur would be captured inside the combustor, and nitrogen oxides would also be reduced. Total cost of Coal Tech's 25-month project is estimated at $785,984 of which 50 percent will be paid by the Energy Department.

The remaining seven proposals are at various stages in the negotiating process. While it is difficult to predict an actual completion date for the negotiations without compromising the government's negotiating position, our expectation is to have all of the agreements finished by the end of June.

## The President's Expanded Clean Coal Initiative

On March 18, 1987, President Reagan announced several steps to ensure a continued close working relationship between the U.S. and Canada in determining and addressing the environmental effects of acid rain. The centerpiece of the President's initiative was his directive to seek $2.5 billion over a five year period to fund innovative clean coal technology demonstrations. The commitment represents the full amount of the government's share of funding recommended by the Special Envoys on Acid Rain, Drew Lewis of the United States and William Davis of Canada, in their January 1986 report to the President and Prime Minister Mulroney.

The President's announcement fulfills a commitment made last year to Prime Minister Mulroney. But in addition to addressing a pressing national concern of many Canadians, the President's initiative will also return significant benefits to this nation -- not only in terms of cleaner air and the increased use of our most abundant energy resource, but also in the form of enhanced technological leadership and the potential for improved international trade.

The President's pledge is to seek funding in the amount of $500 million a year for five years. The funding would be used to structure multiple rounds of competition. The competitive procurements would be sequenced in such a way as to encourage new, potentially improved clean coal concepts to continue their development progress and to be considered as candidate technologies once they reach sufficient maturity.

Projects will be evaluated, as fully as practicable, using the criteria recommended by the Special Envoys and taking into account advice from an advisory panel to be appointed by the Secretary. For example, special consideration will be given to those technologies that can be applied to existing facilities currently dependent on the use of high sulfur coal. Projects will be judged on their potential for economically reducing emission rates for $SO_2$ and NOx. Weighting factors may be used to reflect emission reductions that could help lower pollutants that affect Canadian ecosystems.

As an indication of the Administration's commitment to move forward aggressively with this program, we will request that the full amount of funding directed by the President -- $2.5 billion -- be made available to the Department in appropriations for FY 1988 and advance appropriations for FY 1989, 1990, 1991 and 1992.

In this way, private industry, which will be expected to contribute matching funds at least equivalent to the government's share, will be assured that funds will be available to carry out the full extent of the 5-year, $500 million per year program.

In fiscal year 1988, we propose that the $500 million request be made up of $350 million to be drawn from the remaining funds in the Clean Coal Technology Reserve Fund and the approximately $150 million previously appropriated and scheduled to be available in fiscal 1988 for the first round of Clean Coal Technology projects.

We propose to include a portion of the first-round funds in the President's initiative because, while we recognize that Congress established the initial program under much broader guidelines than the President proposes to use in subsequent rounds, several first-round projects meet the more focused criteria of the Special Envoys. Five of the projects employ technologies that, either as demonstrations or in commercial application, fit the Lewis-Davis criteria -- that is, they can be used to improve the environmental performance of high-sulfur coal burning facilities in a cost-effective manner.

Therefore, we believe credit should be applied in FY 1988 to the anticipated federal share of the relevant projects. That amount is approximately $150 million -- the same funding level proposed as the Round #1 funding increment scheduled to be available in FY 1988.

Should Congress approve the request for advance appropriations of $500 million for fiscal 1989, we plan to combine the $350 million in new FY 1988 funding with the $500 million from FY 1989 to issue a competitive solicitation of $850 million. Our target date for releasing the solicitation would be by the end of this calendar year, pending Congressional approval.

Subsequent solicitations would then follow between 1988 and 1992 -- each one drawing on the experience of the past competition, combined with guidance from the advisory panel and direction from Congress. The funding profile for both the Round #1 Clean Coal Technology Program and the President's expanded program can be depicted as follows:

## INNOVATIVE CLEAN COAL TECHNOLOGY MULTI-YEAR FUNDING PROFILE

| FISCAL YEAR | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|
| CLEAN COAL TECHNOLOGY PROGRAM - 1ST ROUND | $100 | $150 | $150 | | | | |
| REMAINING CLEAN COAL TECHNOLOGY RESERVE FUND | | | 350 | | | | |
| ADDITIONAL APPROPRIATIONS | | | | 500 | 500 | 500 | 500 |
| | $100 | $150 | $500 | $500 | $500 | $500 | $500 |

PRESIDENT's PROGRAM

⬚ FY 1988 PROPOSED SOLICITATION

## The "Retrofit, Repowering and Modernization" Informational Solicitation

Much of the basis for proceeding with the President's expanded program came from the substantial industry response to the Department's recent request for "Statements of Interest" and "Informational Proposals" for retrofit, repowering and modernization technologies. This exercise provided ample evidence that industry was prepared to participate in a joint government-industry clean coal technology effort oriented toward existing coal-burning facilities.

Congress in Pub. L. No. 99-500 (the "Department of the Interior and Related Agencies Appropriations Act for FY 1987," which was signed into law on October 18, 1986) required that the Department solicit expressions of interest from the industry for these types of clean coal concepts. The Department complied with the Congressional directive by issuing a Program Announcement in the Nov. 12, 1986, Federal Register (51 FR 41060-6) and a notice in the Nov. 17, 1986, Commerce Business Daily.

A total of 139 responses were received. Additionally, some letters were received regarding various aspects of the solicitation; these were not counted as submittals. The table on the next page is taken from the Department's "Summary Report to Congress on Emerging Clean Coal Technologies Capable of Retrofitting, Repowering, or Modernizing Existing Facilities" which was forwarded to the Congress on March 6, 1987. A more detailed analysis is currently being prepared and will be provided to Congress by May 12, 1987. The table provides a summary of the submittals categorized by technology, and indicates the total dollar value of all of the projects described for each category.

We should emphasize that the "statements of interest" are not firm project proposals. DOE has not evaluated them on their merits or in relation to prospective program selection criteria. Also, in examining the total value, note that not all of the submittals provided estimates of project costs.

DISTRIBUTION OF SUBMITTALS RECEIVED BY TECHNOLOGY
(in descending order of number received)

| Technology | Number Received | Total Value[2] | Percentage of Grand Total Value |
|---|---|---|---|
| Flue Gas Cleanup | 49 | $ 706,028,000[1] | 13.7 % |
| Coal Preparation | 25 | 409,003,000[1] | 7.9 |
| Fluidized Bed Combustion | 15 | 1,072,516,000 | 20.8 |
| Advanced Combustors | 13 | 230,535,000[1] | 4.5 |
| Alternative Fuels | 13 | 218,141,000 | 4.2 |
| Surface Coal Gasification | 11 | 1,903,200,000 | 36.9 |
| Heat Engines | 3 | 62,179,000 | 1.2 |
| Industrial Processes | 3 | 57,500,000 | 1.1 |
| Other Repowering[3] | 3 | 23,000,000[1] | 0.4 |
| Coal Liquefaction | 2 | 71,000,000 | 1.4 |
| Fuel Cells | 1 | 6,000,000 | 0.1 |
| Magnetohydrodynamics | 1 | 400,000,000 | 7.8 |
| TOTALS: | 139 | $ 5,159,102,000* | 100.0 % |

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Notes:

(1) Five of the submittals did not provide project cost information, as follows: two in the Flue Gas Cleanup category, and one each in the Coal Preparation, Advanced Combustors, and Repowering categories.

(2) Values reflect total project costs as provided by the submitters, including both governmental and private sector cost-shares. The data have not been evaluated and are reported as received.

(3) The Other Repowering category includes those submittals of repowering projects where the specific technologies that would be used have not been specified.

## The President's Program -- Expanding an Ongoing Nationwide Effort

The U.S. has made extraordinary progress in the development of a slate of clean coal technologies both in federally sponsored efforts and in the efforts financed by the private sector and by State governments.

Between 1980 and 1985, approximately $1.6 billion of a total of $3.2 billion for coal technology development was spent by both public and private research programs on advanced coal technologies with inherent reduced emissions. Now, with a major goal to improve the options available for reducing emissions from coal-fired powerplants, the Nation is on an expanded course to develop and demonstrate a broad slate of technologies which used singularly or in combination will result in more efficient and effective emission controls.

A recent DOE report entitled "America's Clean Coal Commitment" (Feb. 1987), prepared prior to the President's March 18 announcement, documented an expected expenditure of more than $6 billion between 1986 and 1992 to develop and demonstrate new clean coal technologies. Approximately $4.9 billion of the $6 billion would be made up of specific clean coal projects, i.e., projects that will operate at a sufficiently large scale to demonstrate the viability of the innovative technology. The remainder of the funding is comprised of privately and publicly financed research and development efforts focused specifically on the cleaner use of U.S. coal.

Within the $6 billion total, the non-federal contribution would amount to an expected $3.9 billion, of which $370 million will come from the Electric Power Research Institute (EPRI), the research arm of the utility industry. State government funding will also make a significant contribution to this total. While State-funded projects are underway in several States -- for example, in West Virginia, Pennsylvania, Virginia, Kentucky and several others -- Illinois and Ohio in particular have taken an aggressive role in financing large-scale development and demonstration efforts. The expected contribution from these two States alone amounts to more than $300 million.

The President's March 18 initiative, with its associated cost sharing from industry, means that new projects costing in excess of $4 billion will be added to these nationwide totals.

## Benefits of Clean Coal Technology

Clean coal technologies offer the potential to:

1. Control large amounts of the $SO_2$ and $NO_x$ released from coal-fired power plants including those in the environmentally-sensitive Northeast.
2. Return economic benefits to American consumers by permitting clean energy to be generated without financially constraining capital investments for environmental controls.
3. Retrofit and repower aging coal-fired power plants, particularly those in the East.
4. Use high-sulfur coals, thereby avoiding the social disruptions associated with massive coal switching, and
5. Reduce acid rain related emissions -- especially from aging power plants in the Nation's northeast quadrant.

Although commercial deployment is already beginning for some technologies like atmospheric fluidized-bed combustion and integrated gasification/combined cycle, how rapidly these innovative clean coal technologies will be deployed depends upon many factors. Two of the most important are (1) technology risk -- concern about the performance and reliability of the technologies; and (2) market demand -- influenced, for example, by the growth in demand for electricity and the future regulatory environment.

The federal and private funding to be expended between 1986 and 1992 on clean coal technologies directly addresses the technological risk. By developing and demonstrating new technologies at commercial- or near-commercial scale, industry acceptance will likely be accelerated. Market demand, however, will depend on a number of complex factors that vary significantly from region to region, and even from site to site.

Many of the emerging clean coal technologies are designed to generate electric power cleanly and more efficiently than is possible today. There is little doubt that electricity is vital to the future of the U.S. The Nation's health depends on continued economic growth, and if adequate electrical generating capacity is not available, we run the risk of undermining this growth.

Coal can provide much of the resource base to ensure continued economic progress. But utilities have been understandably reluctant in recent years to invest in large, conventional baseload power plants -- either coal or nuclear fueled. The uncertainty over anticipated growth in power demand, coupled with uncertainty regarding future environmental regulations, has stalled many construction projects.

In those regions of the country where the demand for electricity is expected to increase, utility owners are now, or will soon be, faced with the need to install new generating capacity. The need for additional electricity will likely intensify as we approach the mid-1990s when the majority of existing coal-fired power plants will turn 25 or more years old. At that point, utilities must consider various options if they wish to continue producing power from these aging facilities.

These events -- today's slowdown in construction and the anticipated future demand for new facilities, either to meet new demand or as replacements for older units -- have combined to create a "window" for new clean coal technologies that will open even wider in the 1990s.

For those utilities that face the dual problem of aging baseload power plants and the need for additional electricity, the repowering technologies -- integrated gasification combined cycle, pressurized and atmospheric fluidized bed combustion -- are especially attractive options. They can be installed relatively quickly (compared to construction of a new baseload plant) and in a modular fashion. This would allow a utility to carry out its construction program in small, less costly increments to meet projected demand growth. And it will help ensure that consumers are not confronted with another cycle of "rate shock" caused by bringing large, new baseload plants into service.

With these repowering technologies, utilities can use much of the balance-of-plant equipment in the aging plant, increase its power output by as much as 150 percent, extend its useful lifetime, and greatly reduce $SO_2$ and $NO_x$ emissions. These technologies are relatively insensitive to coal type and can be installed on most existing coal-fired power plants.

Those utilities confronted with possible requirements for further emission controls will also benefit from the emergence of an expanded slate of retrofit clean coal technologies.

Today, if more stringent environmental controls were to be imposed on existing facilities, utilities would be limited to three options -- flue gas scrubbing which is very costly, switching to low-sulfur coals which could create severe socio-economic impacts, and coal cleaning which is limited in reducing $SO_2$ emissions.

The expanding slate of innovative clean coal retrofit technologies should provide substantially improved options that are preferable to the choices available today. These new technologies offer the flexibility to be used individually or in combination with one another to achieve emissions control of both $SO_2$ and $NO_x$. They provide cost-effective options for the diverse inventory of coal-fired power plants, including those that are limited in available space. They permit the full range of coals to be used in small, moderate or large size boilers. And they produce waste products that are more easily and safely disposable or, in some cases, saleable.

Finally, the availability of demonstrated clean coal hardware can give America a substantial marketing advantage overseas. Worldwide consumption of coal is expected to increase by more than one-third between now and the end of the century, primarily because of increasing coal-fired electric generating capacity. As in the U.S., growth in the demand for coal by many industrialized and developing nations will likely be accompanied by increasing concerns over environmental impacts. The improved coal technologies being developed and demonstrated in the U.S. will be able to meet the environmental objectives of the international community.

Moreover, because America's clean coal projects will provide commercial-scale performance data using U.S. coals, the potential exists to link U.S. coal exports and U.S. technology in a way that enhances America's competitiveness in both. The "packaging" of U.S. coal and the technology to use it cleanly and efficiently can become an important byproduct of the Nation's clean coal technology program.

This completes my formal statement. I will be pleased to answer any questions the Committee may have.

Senator FORD. Thank you, Mr. Secretary.

I think one question we need answered today, that I do not know how many people know about it. I hope you do. But as I understand it and as several of my colleagues understand it, President Reagan has agreed to consider an international accord with Canada on emissions control.

As I say, very few people really know what that means. Can you tell us what the President agreed to?

Mr. WAMPLER. I can't give you any personal insights on his direct conversation with the Prime Minister, Mr. Chairman. But I can say several things about the meeting. The issue of acid rain, of course, was the chief topic of discussion.

I believe that, in general, the Canadians were pleased with the $2.5 billion initiative. However, they're also pressing for an accord with the U.S. that would reduce acid rain precursors.

I think the President was very conscious of the great degree of importance the Canadians place on this issue, and he clearly didn't want to shut the door on any future discussions. But I think it's important that we make the point that the President agreed only to discuss the possibility of concluding an agreement. He did not commit himself to concluding one.

And the issue is now being taken up within the Administration, but there is no timetable set for any specific action at this point in time, Mr. Chairman.

Senator FORD. Now, so what you are saying, then, to the Committee is that he did not agree to anything?

Mr. WAMPLER. He agreed, Mr. Chairman——

Senator FORD. He agreed to study?

Mr. WAMPLER [continuing]. To take a look at a possible accord, yes.

Senator FORD. That suits me all right.

I think you are being a little bit less than honest with us or with people when you look at the budget, when you talk about $2.5 billion, $500 million a year for the next five years, and you are using the $350 million that we already are supposed to be using from the Synthetic Fuels Corporation, then the $150 million that we are authorizing to make your $500 million for your first year.

That seems to me to be $500 million short.

Mr. WAMPLER. Well, that's the structure that we have submitted a request for. We thought, if you look at the makeup of the first year funding, $150 million is already set aside for Clean Coal I projects that do meet the criteria. So, we thought it was proper to include those projects as part of the expanded initiative.

Senator FORD. So you are getting credit for it without spending any additional money?

Mr. WAMPLER. Well, the money will be spent.

Senator FORD. I know, but without any additional money. So Congress had already set this up and it was in our criteria and we were spending that money and we authorized it, and you're just going to take credit for it and the first $500 million of the $2.5 billion you will not be asking for.

And that will be really a $500 million shortfall as it relates to the $2.5 billion we are talking about.

Mr. **Wampler**. Yes; we're asking for the $350 million remaining in the reserve, plus credit for the $150 million that are in projects in round one that meet the criteria.

Senator **Ford**. So on the President's program, you are going to submit legislation authorizing the program.

Mr. **Wampler**. Yes.

Senator **Ford**. When will that—when can we expect that to be up here?

Mr. **Wampler**. I just had a discussion on that. The legislation is currently in draft form within the Department. I had a discussion yesterday with some of my colleagues at the Department. I reinforced the opinion that this should be acted upon as rapidly as possible.

It will be coming up here very soon. If I was successful in my conversations yesterday, it will be extremely soon.

Senator **Ford**. We could not get it by Easter Sunday, could we?

Mr. **Wampler**. We'll expedite it as much as possible, Mr. Chairman.

Senator **Ford**. Will it be before our hearing, then, on the 18th of May?

Mr. **Wampler**. It may. We're not sure. We'll try to meet that deadline.

Senator **Ford**. I'm going to ask you to answer some questions in writing, Mr. Secretary, if you will.

Mr. **Wampler**. Certainly.

Senator **Ford**. And they will be so we will have it for the record, and as we go down the line: What did the President agree to? And I think I have asked you that question, and I want the answer in writing.

And who would implement the agreement, under what he said he would do? When and how? So that is getting down to, you are saying you should have it up here hopefully by May the 18th.

And where will the benefits and costs fall? I want that answer, too. And will certain geographic regions of the country or certain sectors of the economy benefit more than others? Or will certain regions or economic sectors pay more than others?

One final question which will be for the record this morning: Does the attitude now of the Administration in what you say is coming up here, does this represent a change in this Administration's position as it relates to acid rain and/or clean coal?

Mr. **Wampler**. Well, I believe the initiative of $2.5 billion is a very strong commitment that's been made by the President. I think that the statement has certainly been made that the Administration has changed its mind. I'd like to address that.

If you look back at the Administration's original position, it was based on two factors. One was a potential negative impact on the deficit reduction goals, and second, other was the belief that the government shouldn't be involved in marketplace decisions.

And I will address each of those. Since that time, we've had a series of events that have changed. In our first round of competition, we found that the private sector was indeed willing to participate, both in terms of technical ideas and, most importantly, in some very substantial financial contributions.

In fact, if you look at Clean Coal I, the funding ratio of that program is 65 percent to 35 percent, 65 percent being the private share. That of course reduces the impact on the deficit, due to this significant private sector contribution.

Another factor is, there is no doubt increasing attention being given to the problem of acid rain, which was highlighted by the Special Envoys' report. It's become an issue of increasing concern.

We still have our concerns about budgetary pressures. But I think the events of the last year, the need to move forward both on a scientific and technological basis regarding acid rain, the recommendations of the Special Envoys, the commitment of President Reagan to Prime Minister Mulroney have all been factors that have led to this new initiative on acid rain.

Senator **Ford**. Let me see—let me ask you this. I understand that the criteria to be used for selecting the projects for the program are those that were recommended by the joint envoys in their January 1986 report. Am I correct in that?

Mr. **Wampler**. Yes, you are, Mr. Chairman.

Senator **Ford**. Can you describe these criteria for me?

Mr. **Wampler**. The criteria in the Envoys' Report and the principal goal of the envoys' report, and I think it's important that we remember this, was to expand the menu of technologies that would impact sulfur and nitrogen oxide control.

The specific criteria was as follows: The federal government should co-fund projects that have the potential for the largest emissions reductions, measured as a percentage of $SO_2$ and $NO_x$ removed. Among projects with similar potential, government funding should go to those that reduce emissions at the cheapest cost per ton. That was the second criteria.

The third criteria was that more consideration should be given to projects that demonstrate retrofit technologies available to the largest number of existing sources, and so on.

And fourth, that special consideration be given to technologies that can be applied to facilities currently dependent on the use of high sulfur coal.

I might point out also, Mr. Chairman, that these criteria were developed following a year long review by two very able people, Mr. Drew Lewis and Mr. William Davis. There are a couple of things I would like to say about these criteria.

They're clearly useful guidelines in helping us fashion a properly targeted Clean Coal program. I believe they do put this nation on a course towards fixing the problem, rather than just patching the problem.

I'd point out, however, that the Envoys' recommendations are not specific procurement criteria. Words such as "more consideration," "special emphasis," we must be translated into specific weighted factors for competition. That's going to be our task over the summer.

And we'll certainly be using the advice of the Innovative Control Technology Advisory Panel as we do this.

Senator **Ford**. In your criteria, did I understand that--on retrofitting, that is one of the criteria, technology as it relates to retrofitting?

Mr. **Wampler**. Yes.

Senator FORD. Do you have a criteria as relates to technology of new applications? You are just kind of limiting it to retrofitting and there is no emphasis on technologies for new applications?

Mr. WAMPLER. I think you have to look at the way you define "retrofit." In our definition of "retrofit," we include repowering and modernization. I think it's very important that we continue to include repowering and modernization in our definition. Because, if you look at the technologies that are being developed for repowering, in addition to the control of emissions, you get increased performance. It lets you have technologies that penetrate the marketplace better and you have the least impact on consumer costs.

Senator FORD. What are the benefits to repowering technologies and what kinds of technologies are they? The EPRI and IGCC that we heard of last week is one of those, is it not?

Mr. WAMPLER. Yes, it is, Mr. Chairman. We feel these are the most promising classes of technologies to be developed.

We're looking at PFB and combined cycle, gasification projects. These projects are coming along well. We will make the point again that they do give you some very substantial increase in efficiency, thus they do lower the cost.

Senator FORD. Are you, in the minds of the Department, changing your approach based on legislation that may be introduced on what direction you want to go?

You have another solicitation coming. Is that going to be held up in any way? Are you going to proceed with the ones you have already approved? You have already announced two and your funding for that you are moving on. Is there anything going on now that would change or accelerate or slow up the position that you are in as it relates to new solicitations?

Mr. WAMPLER. No, Mr. Chairman, not at all. We are continuing. We do have two projects negotiated and finalized. We do have two more projects that, as we speak, are imminent.

Senator FORD. I thought you might announce those this morning. Something surprising always happens at a hearing.

Mr. WAMPLER. We tried, Mr. Chairman.

Senator FORD. I am disappointed.

Mr. WAMPLER. But those are imminent. And we are continuing the negotiation of the remaining four, and we are expediting that as rapidly as possible under the guidelines that were established under Clean Coal Technology I.

Senator FORD. Now, let me go back, then. You said earlier that the government's costs for the first two projects were about 35 percent?

Mr. WAMPLER. The average cost of all nine projects is 65/35, the government share being 35, yes, sir.

Senator FORD. Okay. Now, when you talk about $2.5 billion, will the $2.5 billion be 35 percent, or will you figure up the total projects, as has been done to me in the past, and say the projects total $2.5 billion and that is the end of it?

Mr. WAMPLER. No, Mr. Chairman. The $2.5 billion is the federal share only.

Senator FORD. I understand that. But you will look for projects beyond—say 35 percent is $2 billion and you have got $500 million left of all the nine. Will you look for more projects to go ahead and expend the other $500 million?

Mr. **Wampler**. Yes, we will.

Senator **Ford**. Okay. So I don't want you to say we have got projects out here that total $2.5 billion, we have only invested 35 percent, so we have met our $2.5 billion projection.

Mr. **Wampler**. No, we will not do that.

Senator **Ford**. Okay. I have got you on record. I wish I had sworn you to that. [Laughter.]

Senator **Hecht**. Mr. Chairman.

Senator **Ford**. Yes, sir.

Senator **Hecht**. May I ask one question?

Senator **Ford**. Sure. I am sorry. I just got carried away.

Senator **Hecht**. That is fine, that is fine. I have to leave, but I want to ask one question.

Our focus tends to be on the U.S. problems with air pollution and acid rain. What are the Canadian problems and what is their part in cleaning up the environment as part of the Canadian and U.S. joint efforts?

Mr. **Wampler**. Senator, I'm aware of several letters and several reports that are being prepared on those topics at this point in time. I'd like, if possible, to provide you an answer for the record on that.

I haven't had a chance to review some of these things. The Canadians are, in general, making a commitment to reduce emissions, and they have a time frame and a specific reduction target in mind. But if possible, I'd like to furnish you that for the record and make a more detailed response.

Senator **Hecht**. Would you, please. And what part the Canadians contribute to the acid rain, what part the Americans contribute, theoretically?

Mr. **Wampler**. Senator, I certainly will do that.

Senator Hecht: Thank you.

[The information follows:]

## CANADIAN VIEWPOINT OF THE ACID RAIN PROBLEM

According to the recent Canadian report titled "Stopping Acid Rain", acid rain is causing economic, social, and environmental problems in eastern Canada. It is increasing the acidity of lakes and streams to the point where aquatic life is depleted, and it is increasing the acidity of soil water and shallow groundwater. Acid rain is also suspected of being one of the causes of forest decline. This report also indicates that from an economic perspective, acid rain is endangering fishery, tourism, agriculture and forestry resources in a large part of eastern Canada.

On the other hand, according to the most recent annual report of the U.S. National Acid Precipitation Assessment Program (NAPAP) to the President and Congress, at current levels of acidity, effects on several resources, such as crops, are not demonstrable in this country.

A joint report to the Bilateral Advisory and Consultative Group (BACG), which is sponsored by both the U.S. and Canada, is scheduled for research soon. This report will be the first Joint Report on the Status of Canadian/U.S. Research in both Canada and the U.S. on Acidic Deposition. It encompasses current research programs, the specific response by the U.S. to the research recommendations of the Special Envoys, the current and planned joint research projects, and a list of "new findings" subsequent to the assembly of information for the Special Envoys' report.

Regarding the Canadian emission reduction program, which was announced by Prime Minister Brian Mulroney on March 6, 1985, Canada will reduce total sulfur dioxide ($SO_2$) emissions from sources east of the Saskatchewan/Manitoba border to 2.3 million tonnes (2.6 million tons) by 1994. This represents a 50 percent reduction of emissions from 1980 levels. The program will be implemented over ten years, and contains specific emission reduction requirements.

It should be noted, however, that this emission reduction program must be ratified by all of the affected Canadian provinces. It is our understanding that at least two Canadian provinces (Nova Scotia and New Brunswick) are reluctant to ratify the emission reduction program.

In a detailed letter to EPA, the Energy Department, and the State Department, House Energy and Commerce Committee Chief John Dingell has questioned the significance of Canadian efforts to cut sulfur dioxide ($SO_2$) emissions leading to acid rain -- proclaiming that many plants targeted for cutbacks are using production curtailments rather than permanent, technology-based pollution controls. Congressman Dingell requested comment from these three agencies on his view that the Clean Air Act more strictly regulates U.S. sources than Canada regulates its own sources, and for an in-depth analysis of Canadian programs to reduce $SO_2$ and nitrogen oxides ($NO_x$) on a plant-specific basis where possible. DOE's response to this letter is currently being prepared.

The question regarding the relative contribution of Canadian and U.S. sources to acid rain cannot be easily addressed without knowing which specific location is being referred to. The relative contribution by sources varies significantly by location, wind direction, season, and many other variables. Current acid rain models are currently capable of predicting only the sulfate and sulfur dioxide deposition at a particular locations. They cannot as yet directly predict deposition of nitrogen oxides, nitrates and other major constituents that can contribute to acid rain, such as ammonia calcium, or magnesium. Some critics of these atmospheric models have even noted that the models ability to accurately predict sulfate and $SO_2$ concentrations may be flawed because transport and dispersion calculations over long distances have not been validated by actual monitoring results. Nevertheless, these models are routinely used by some to estimate the contribution of large numbers of sources over a large area to the deposition in another area.

Senator **Hecht**. Thank you, Mr. Chairman.

Senator **Ford**. Certainly, Senator. And I apologize for not allowing you some time earlier.

How many scrubbers are in existence in Canada?

Mr. **Wampler**. To my knowledge, none.

Senator **Ford**. Are there any planned?

Mr. **Wampler**. To my knowledge, there are not.

Senator **Ford**. That tells a big story, does it not? [Laughter.]

Will utilities in your view utilize clean coal technologies on a commercial basis without regulatory changes?

Mr. **Wampler**. When the President announced his initiative, he established a task force headed by the Vice President to look at regulatory impediments. That was certainly an indication that we feel that those are very important issues and that if we are to be successful in getting market penetration for these technologies, we have to look at these regulations very carefully and try to remove those that impede the commercialization of these technologies, yes.

Senator **Ford**. Do you think the current state and federal regulatory climate inhibits the deployment of clean coal technologies?

Mr. **Wampler**. I think that there are regulations in effect now that certainly need to be looked at for this potential.

Senator **Ford**. Are they state or federal?

Mr. **Wampler**. I think they're both.

Senator **Ford**. So you are saying that they need to be looked at, but are you saying to me they will inhibit clean coal technologies?

Mr. **Wampler**. There are some—it is my understanding there are some that will.

Senator **Ford**. Do you think that federal regulatory changes would help remove the barriers to the more widespread use of clean coal technologies?

Mr. **Wampler**. We are in the process, Mr. Chairman, reviewing and evaluating those. We have been in that process for some time. That's exactly what the Vice President's task force will be doing also.

Senator **Ford**. Well, are you familiar with Senator Byrd's bill, S.879?

Mr. **Wampler**. Yes. We're in the process of reviewing that bill at this point in time.

Senator **Ford**. Do you believe that, with what knowledge you have of that bill, that the regulatory problems are adequately addressed in that bill?

Mr. **Wampler**. I'm aware that certainly Senator Byrd has addressed some very specific regulatory changes. He's identified several potential ones in his bill. I think that that information is going to be useful when our task force gets under way.

If you look at the Vice President's charge, he is also to look at state regulations. I think that that probably goes a bit beyond the regulatory changes that were suggested in the Byrd bill.

I might say this about the Byrd bill in addition to that, Senator. I'm pleased to say that there are many similarities between our position and Senator Byrd's bill. They are complementary. I think we can work together on that bill and fashion an approach that meets our common objectives on that bill.

Senator **Ford**. That is one reason that it is important that we get this, get your recommendations by the 18th.

Is there anything we can do to stimulate the states to assist us or to change their rules and regulations so that we might be able to expedite the use of these new technologies?

Mr. **Wampler**. I certainly think that, once we take a good hard look at what changes need to be made, there are certainly ways that we can all work together to do that, yes, Senator.

Senator **Ford**. When will you have time to look at these changes, Mr. Secretary?

Mr. **Wampler**. Well, we're looking at them currently, and we're going to continue looking at them. It's on a fast time frame. We consider it an item of great importance to the Department.

Senator **Ford**. I do not want to keep you too long, but let me ask you this question. What environmental and economic benefits does the U.S. realize from encouraging the development and ultimate deployment of clean coal technologies rather than employing of emissions control technology?

Mr. **Wampler**. There are several economic benefits. Number one—and I've discussed it earlier—is that the installation of scrubbers does not increase efficiency in any way. In fact, it decreases efficiency for the existing power plant.

If you use the technologies that we have available or will have available for repowering, you get a significant increase in efficiency, which translates into lower ultimate cost.

The second advantage you get is that the U.S. is about to become the showcase, through this program, for technologies to burn clean coal. There is every expectation that we can leverage these into increased exports, not only of coal but of technology.

Senator **Ford**. Well, I am glad to know that we are emerging as a showcase.

Did I understand you correctly that a scrubber reduces the efficiency of a generating facility, where the clean coal technologies in your opinion will improve the efficiency?

Mr. **Wampler**. Those technologies that are repowering technologies certainly will increase the efficiency. Scrubbers reduce the efficiency anywhere from six to eight percent.

Senator **Ford**. Any increased environmental problems or side effects that come from scrubbers?

Mr. **Wampler**. The wet sludge waste problem from scrubbers at this point in time is significant. It requires a large surface area of land to dispose of this wet sludge, and it could become an increasing problem as more scrubbers are installed.

Senator **Ford**. Well, we have done very well—30 minutes. And if you will give me those answers in writing, because you are coming on so hard in an area which I enjoy so much, I do not want to even take a minute away from your time of studying those new technologies so you can come forward with a recommendation.

Mr. **Wampler**. Thank you, Mr. Chairman.

Senator **Ford**. Mr. Secretary, we thank you and we thank your colleagues for coming.

Mr. **Wampler**. Thank you.

Senator FORD. Senator McClure has a statement he would like to have placed in the record, and I ask that that be in the record prior to the questioning of the first witness.

Next will be Carl Bagge, President, National Coal Association, and David Webb, Senior Vice President, Policy and Regulatory Affairs, Gas Research Institute.

Well, I thought you two fellows were going to get up there and do it together, and you did not plan to do it that way. But we are going to do it together, how is that? Carl does not bite.

It does not bother you any, does it?

Mr. BAGGE. He doesn't bother me.

Senator FORD. Okay, God bless you. Proceed, Mr. Bagge.

## STATEMENT OF CARL E. BAGGE, PRESIDENT, NATIONAL COAL ASSOCIATION

Mr. BAGGE. Thank you, Mr. Chairman.

I have a formal statement I'd like to introduce for the record.

Senator FORD. It will be included in the record.

Mr. BAGGE. Thank you. I'd like to highlight it if I can, and say that I am Carl Bagge, President of the National Coal Association. And today I want to use this opportunity to discuss the critical importance of our nation's commitment to developing clean coal technologies and the need to transform that commitment, that evolving commitment, into a program to both identify and eliminate the barriers and facilitate the deployment of clean coal technologies.

Up to now we have been demonstrating. Phase one was a demonstration phase of clean coal. Now the concept is to deploy what we in the decade of the seventies researched and then finally demonstrated in phase one and now we will deploy in phase two.

A continuing commitment to clean coal promises to move us toward fulfillment of the vital national objectives of cleaner air and national security. And what impresses me, Mr. Chairman, about the program is that this isn't dependent upon—as the Secretary of Energy testified just before, that the program here that Congress is considering stands on its own.

It's self-operative. It doesn't depend on the imposition of air quality standards to provide the incentives for the utility industry to commit to deployment of clean coal technology.

The fact is that the efficiencies, the combustion efficiencies that will accrue from the deployment of clean coal technology, makes it self-operative and it doesn't depend upon the enactment of any legislation to provide those incentives.

The coal industry strongly supports the clean coal technology program. For the 17 years that I've been President of the National Coal Association, I can think of no program that addresses the needs of both the coal industry and the nation any more vitally and more relevantly than the clean coal technology program, Mr. Chairman.

The program has received added emphasis early last year when President Reagan and Prime Minister Mulroney of Canada endorsed the report of the Joint Envoys on acid rain, and you have addressed some questions regarding that to the Secretary of Energy.

The President recently reaffirmed this commitment in recommending federal government expenditures of a total of $2.5 billion over five years and requesting appropriations of $850 million for the next two years. Senator Byrd has recently introduced his bill, S.879, the Clean Coal Technology Deployment Act, to provide a legislative framework for the deployment program.

I might say that our organization and the coal industry supports both these bills, both the Senator Byrd bill and the Administration bill. It's for the wisdom of Congress for you to determine which will do the job the best.

Let me just say that the new generation of coal-fired generation technologies being developed through the clean coal program will result in markedly reduced emissions per BTU's consumed and increase efficiency and combustion. But I say again, it isn't dependent only upon the perception that the bill will aid in resolving this tension we have with Canada or with the acid rain problem.

It also stands independently as a program in increased efficiency in combustion, which is vitally important to the cost of electricity for the nation. The increase in conversion efficiency, particularly at existing facilities, will permit the nation to generate more power with less fuel, with a reduction of maintenance and operating costs. And this has been documented by some of the projects in the fluidized bed area that are taking place right now, prior to this program.

This fact, which is often overlooked in the discussion of clean coal technologies, is significant. The clean coal program will create marketplace incentives over the life cycle of this new generation for their utilization. I underscore again, this is vitally important, to say it's self-operative.

There are economic, built-in economic incentives that will lead the utility industry to make this commitment to deploy these technologies, irrespective of acid rain legislation.

Let me use this opportunity to share with you the coal industry's perspective on how the clean coal technology development and deployment program will affect coal's future markets and consequently the nation's energy security. This ought to be thought of, rather than, as it's perceived, as an acid rain solution, this ought to be really thought of as a part of our national security response rather than an acid rain fix, which it may be.

But if that happens and flows from it, that's well and good, but that's only incidental in my view.

The energy security report recently presented to the American public by DOE concluded that the country is likely to confront unacceptable levels of oil imports by the early 1990's. And Secretary Hodel has testified here before your Committee just recently to that point.

A key finding of the report is that the only unambiguously cost effective option to stem the rise in imports is the continued substitution of domestic coal in the nation's energy mix, particularly in the generation of electricity, coal's preferred use.

It seems to me that that was a reaffirmation, that report by the DOE that the President ordered last year and was recently reported, is a reaffirmation of the kind of energy policy conclusions that we as a nation arrived at following the oil embargo in 1973.

And it's very comforting for those of us in the coal industry to see that that is reaffirmed, notwithstanding the perception that we have a surplus of oil and gas and these other things.

Electricity demand will continue to grow, and this country will need substantial additions of generating capacity in the 1990's. The coal industry and others, inside and outside the government, have assumed for some time that the next increment of generating capacity will come from coal.

At a delivered price of $1.00 to $1.60 per million Btu's, depending on location, coal is the competitive fuel choice over oil and gas at prices from $15 to $20 a barrel. On a per kilowatt basis, including all social and environmental costs, coal is clearly the choice for the next increment of baseload generating capacity.

We have a window of opportunity, it seems to me, now because we haven't been building the large-scale units of generation. And while we have this opportunity, this open window before we can commit, we have an opportunity now to deploy, to go beyond demonstration, to go to deployment, and to provide an economic basis for the utilities to leapfrog and get into an entirely new generating technology which is embraced by the clean coal concept.

The chief threat to this fundamental assumption of energy policy, that coal will play a significant part in stemming rising oil imports, has been the uncertainty interjected by the calls for massive reductions of SO2 and NOx emissions from stationary sources.

The threat to coal use should be waning. And this is very important, Mr. Chairman, that the threat to coal use in the public's mind ought to be waning as scientific evidence continues to demonstrate that acidity in the environment, the problem is not as severe or as widespread as originally believed by some, nor is it irreversible.

Further, the Clean Air Act is working as intended. And with the massive scientific evidence that's now coming to the forefront, the hysteria ought to be abating. But it's not. Instead, it continues to increase.

Perhaps the larger threat to this fundamental energy policy assumption comes from the changes in how the domestic electric utility industry is regulated. And here we deal at pages 6 through 7 and 8 in my formal statement with the problem of the PUC's and how the institutional barriers that exist and the failure of how we as a society regulate the utility industry by the state PUC's operates as an institutional constraint on making the kind of capital commitments the utility industry has to make to go forward with this program.

And as Senator Byrd's bill—and I'm happy that you raised the question with the Secretary of Energy asking specifically about the viability of the provisions of the Byrd bill that try to address the problems of these institutional barriers by the state PUC's in making the program go.

And I think that the answer has to be—and I agree with Secretary Wampler that I think he addresses the problem, because the federal government can only deal, as an old FPC Commissioner I can tell you personally, only deal with the federal regulation on interstate wholesale sales.

But it can be a persuasive effect if, as the bill, Senator Byrd's bill, provides that the states have to be involved early on before a utility makes a commitment to a clean coal technology program, so in effect they're signing off and the prudency test ought to be met.

There is a presumption in the bill that the commitment of capital funds is prudent and that the rug won't be pulled out from under the utility after the facility is constructed and operating, which has been tragically the cause of the uncertainty which has led to this in the past.

There have been no new orders for baseload coal plants for several years because the utilities can't get the cost of capital back and because of these uncertainties, massive uncertainties.

In the recent past, 8,300 megawatts of coal-fired capacity has been dropped from our forecast nationally and another 12,500 have been delayed for an average of 20 months. The utility industry and the coal industry are literally at a crossroads right now. How we go and where we go, the opportunity is now embraced in these bills to permit the utility industry to be relieved of some of these institutional barriers and to permit coal to be burned cleanly and more efficiently, for the benefit of the nation, the coal industry, and the utility industry.

And thank you very much. I'll leave the rest to my formal statement. Thank you.

[The prepared statement of Mr. Bagge follows:]

NATIONAL COAL ASSOCIATION

Statement of

Carl E. Bagge
President
National Coal Association

before the

Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources

United States Senate

April 9, 1987

## CLEAN COAL TECHNOLOGY DEVELOPMENT AND DEPLOYMENT

Mr. Chairman, I am Carl Bagge, President of the National Coal Association. In that capacity today, I am representing the joint membership of the National Coal Association and the Mining and Reclamation Council of America (MARC) which formally merged on April 1. Our combined organization represents almost all the Nation's coal production and includes the full spectrum of coal operators from all producing regions of the United States.

Today I want to discuss the critical importance of our Nation's commitment to developing clean coal technologies and the need to carry transform commitment into a program to both identify and eliminate the barriers and facilitate the deployment of clean coal technologies.

The clean coal technology program, which has been promoted through the leadership of the Majority Leader, yourself, and others, establishes a solid foundation on which the United States can successfully pursue its environmental and energy policies without unduly burdening and damaging significant sectors of our economy.

A continuing commitment to clean coal promises to move us toward fulfillment of the vital national objectives of cleaner air and energy security. And it will position the United States on the leading edge in marketing and exporting technologies which provide increased fuel efficiency with reduced emissions. The benefits of this program will accrue not just to the United States but to other industrialized societies, now and in the future.

The coal industry strongly supports the clean coal technology program. Working with the Clean Coal Technology Coalition over the last three years, we have seen the Department of Energy, with the strong cooperation of private industry, establish a cost sharing program to develop and demonstrate clean coal technologies applicable to all phases of the coal combustion cycle.

The program received added emphasis early last year when President Reagan and Prime Minister Mulroney of Canada endorsed the Report of the Joint Envoys on Acid Rain recommending a five-year, five billion dollar joint industry/government clean coal technology program. That commitment, which was recently reaffirmed, specifically chose the path of clean coal technology as the rational way to continue our steady progress under the current Clean Air Act, rather than a costly and possibly ineffective "acid deposition" emission control program. The

President recently reaffirmed this commitment in recommending Federal Government expenditures of a total of $2.5 billion over five years and requesting appropriations of $850 million for the next two years. Separately, Senator Robert Byrd recently introduced S.879, the "Clean Coal Technology Deployment Act", to provide a legislative framework for a clean coal technology deployment program. Senator Byrd's bill takes an important first step in identifying and addressing the regulatory, or non-market, impediments to the utilization of clean coal technologies. S.879 deserves serious and expeditious consideration by this committee.

The new generation of coal fired generation technologies being developed through the clean coal program will result in markedly reduced emissions per Btu's consumed and increased efficiency in combustion. The increase in conversion efficiency, particularly at existing facilities, will permit the Nation to generate more power with less fuel with a reduction of maintenance and operations costs. This fact, which is often overlooked in the discussion of clean coal technologies, is significant. The clean coal program will create marketplace incentives over the life cycle of this new generation for their utilization. Whether achievement of these economic efficiencies will occur will be a function of the national commitment to the clean coal program and the resolve to facilitate their market introduction through elimination of constraints and the provision of incentives for their demonstration on a commercial scale sufficient for acceptance in the regulated climate of power generation.

Last week, expert testimony was presented on the status, problems and promises of specific portions of the Clean Coal Technology Program. Today Assistant Secretary Wampler has outlined the Administration's commitment to clean coal and DOE's implementation of the program to date.

Let me use this opportunity to share with you the coal industry's perspective on how the clean coal technology development and deployment program will affect coal's future markets and consequently this nation's energy security.

In response to growing public concern for the energy security of the country, this past Fall, at the direction of the President, the Energy Department coordinated an exhaustive study of the problem, its components, and the options available for addressing it. The resulting Energy Security Report concluded that the country is likely to confront "unacceptable" levels of oil imports by the early 1990's or sooner. A key finding of the report is that the only unambiguously cost-effective option to stem the rise in imports is the continued substitution of domestic coal in the nation's energy mix, particularly in the generation of electricity--coal's preferred use.

DOE's study reflected the consensus of most government and private experts that electricity demand will continue to grow and that this country will need substantial additions to generating capacity in the 1990's.

The coal industry and others inside and outside of government have assumed for some time that the next increment of generating capacity will come from coal. Economics and energy security concerns would preclude oil or natural gas from this market. Nuclear power's contribution is not expected to significantly expand in the near term.

At a delivered price of $1.00 to $1.60 per million Btus, depending on location, coal is the competitive fuel choice over oil and gas at prices of from $15 to $20 a barrel. On a per kilowatt basis, including all social and environmental costs, coal is clearly the choice for the next increment of base load generating capacity.

The chief threat to this fundamental assumption of energy policy -- that coal will play a significant part in stemming rising oil imports -- has been the uncertainty interjected by calls for massive reductions of $SO_2$ and $NO_x$ emissions from stationary sources. This threat to coal use should be waning as scientific evidence continues to demonstrate that acidity in the environment the problem is not as severe or widespread as originally believed by some, nor is it irreversible. Further, the Clean Air Act is working as intended. The dramatic and steady decline in $SO_2$ emissions--28% from their peak in 1973--continues in spite of a more then 50% increase in coal use. Preliminary data indicate this trend continued in 1986 and will continue well into the future.

Perhaps a larger threat to this fundamental energy policy assumption comes from changes in how the domestic electric utility industry is regulated. The Energy Security study pointed out quite clearly that despite an array of familiar problems facing the coal industry, the major impediment to new coal generating capacity is rooted in the so-called "prudency review" problem at the public utility commission level in many states. Rapid inflation in the 1970's, high cost overruns, and overestimates of capacity requirements as a result of conservation created political and internal pressures that led many of the state PUCs to break the "regulatory contract". This is the familiar agreement by which a utility accepts a regulated but fair rate of return in exchange for an exclusive market. It has worked well for decades and permitted the American utility industry to grow into the most advanced in the world.

Unfortunately, many PUCs have gladly accepted the authority to regulate returns on new investments, including the authority to deny any return if an investment is determined after the fact to be "imprudent", without accepting the responsibility to share in the risks of those investments in new capacity. Conversely, when investment decisions have been sound, the PUCs often allocate most of the benefits to consumers, not to the investors. The resulting asymmetry of risk is a "heads I win, tails you lose" attitude by the PUCs. Consequently, utilities have been driven increasingly into a highly risk-averse mode with respect to investments in new capacity.

Utilities are increasingly avoiding investments in high up-front capital intensive coal plants but with low life cycle costs. They are opting for sub-optimal, smaller, incremental additions of natural gas capacity where the low capital costs can be written off quickly in the present and high operating costs passed on into the future. Simultaneously, there has been a sharp rise in applications filed under the Public Utility Regulatory Policies Act by potential non-utility electricity suppliers that are gas or oil-fired. The increase in imports of Canadian power is another manifestation of this problem.

In contrast, there have been no new orders for baseload coal plants for several years. In the recent past, 8,300 megawatts of coal-fired capacity has been dropped from forecasts and another 12,500 has been delayed for an average of 20 months. Some of this is due to uncertainties in load growth projections. However, the evidence is quite convincing that major additions to capacity must begin. The mid-range of forecasts shows continued demand growth between 2 and 3 percent a year. This means new capacity of 100,000 megawatts by the year 2000. The Energy Security study clearly points out that the PUC problem is leading us to a situation in the 1990's of capacity shortages and/or a doubling of consumption of oil and gas for the generation of electricity over the next two decades.

Mr. Chairman, last week's hearings on the subject of clean coal technology demonstrated two things. First, the expert testimony pointed out that emerging clean coal technologies can be cost effective means for generating electricity in an environmentally acceptable manner. Further, they can be built in smaller increments, which will facilitate utility load management and partially, obviate the PUC prudency problem. Viewed in this manner, clean coal technologies offer another option for coal to meet the fundamental energy policy assumption that I have been talking about. The joint federal/private clean coal technology demonstration and deployment effort is an appropriate and prudent investment, and it will further the Nation's fundamental energy policy objectives.

The second point to emerge was the energy policy significance of the prudency review problem, not only to general utility investment decisions but to the introduction of new commercial technologies in a regulated utility. Senator Byrd's proposal explicitly addresses this barrier by calling for a rebuttable presumption that "any clean coal project expenditure is prudent" for rates and charges under FERC jurisdiction and encouraging state PUCs to adopt similar procedures. As reflected in the assignment of a Vice Presidential Task Force to examine existing regulations impeding the deployment of clean coal technologies, the impact of the "prudency review" on energy security is shared by the Administration.

The coal industry commends you, Senator Ford, and the members of the subcommittee, for providing a focus for the promise of coal in meeting both our energy and environmental objectives through the aggressive implementation of the clean coal technology program. We further exhort the committee to move forward with a program to identify and eliminate the constraints on utilization of these emerging technologies.

We look forward to working with the committee in that effort.

Senator Ford: Thank you very much.

Mr. Webb, do you want to go ahead with your statement.

## STATEMENT OF DAVID O. WEBB, SENIOR VICE PRESIDENT, POLICY AND REGULATORY AFFAIRS, GAS RESEARCH INSTITUTE

Mr. Webb. Thank you, Mr. Chairman.

I'm David Webb of the Gas Research Institute and I'd like to ask that my full statement please be included in the record.

Senator Ford. Your statement will be included in the record.

Mr. Webb. Thank you very much. I'll summarize.

I appreciate the opportunity to appear before you today to discuss the important role that gas can play as just one element of a national clean coal program. The role of gas is often overlooked in any discussion regarding clean coal technologies.

Yet we have been working with EPA and EPRI and some of the other firms and have documented laboratory results that indicate the use of gas in a small amount, 10 to 15 percent, in some of these new technologies results in a cost effective retrofit approach to simultaneously reducing nitrogen oxide, $NO_x$, and sulfur dioxide emissions from flue gases.

The average results from these laboratory tests indicate that we can achieve up to 60 percent reductions in $NO_x$ and 50 percent reductions in $SO_2$. The next step obviously, is to demonstrate these gas technologies in retrofit applications in commercial utility boilers. This will occur during the next three or four years as part of the Department of Energy's clean coal technology program.

If these demonstrations are successful--and based on the laboratory results, we are very optimistic—then gas-enhanced emission control processes will provide an extremely cost effective solution for simultaneously reducing $SO_2$ and $NO_x$.

For this reason, I urge the members consider in any expanded clean coal program the fact that these technologies should have a priority for being demonstrated.

A couple of items I want to point out. On April the 24th of '84, the Secretary of Energy asked the Energy Research Advisory Board to convene a panel particularly to assess clean coal technologies in the use of coal. The report was issued in '85 and several of the findings I think are still relevant today as you consider these new clean coal technology bills.

One was that coal use in the U.S. is expected to continue to increase for the next 25 years.

Two, direct combustion of coal will continue to represent over 90 percent of all coal used for the rest of this century and beyond.

And three—and I think perhaps this is the most important—the number of specific coal use situations is so large and diverse and the specific problems are so site specific that no general applicable solution can be presented. This issue is even more difficult when applied to retrofit situations, which represent the overwhelming majority of applications.

In other words, there is no one blanket approach such as scrubbers that will apply to all these situations. I think that's important.

The panel went on and made three specific recommendations in its report to the Secretary of Energy that I think again are worth repeating:

One, it said that early demonstration of retrofit technology is the most urgent;

Two, it said it's important to make sure that high sulfur coals that can be mined at relatively low cost are given priority for the test work. The report said this includes coals from Kentucky, Illinois, Indiana, Ohio, and West Virginia.

And three, it said the basic goal of the research will not be achieved unless we can apply new processes to the high sulfur coals.

So I think in looking at any program with those goals in mind that you ought to be able to give some direction to the Department in this.

As I said, we have been funding with EPA over the past three years this technology of what we call gas reburn sorbent injection, where we actually are mixing 10 to 15 percent gas with limestone injected into the flue gas to reduce both $NO_x$ and $SO_2$.

This is one of the more promising near term retrofit applications. SO2 control strategies based on injection of calcium-based sorbents into the combustion chamber has been under research for quite a few years in this country. It appears in some of our basic research that you can increase the cost effectiveness and also enhance some of the benefits of the calcium-based sorbents when you use gas in very small quantities to inject the fuel, if you would, into the combustion chamber.

Recently the Japanese have introduced a new $NO_x$ control strategy which involves in-furnance $NO_x$ reduction by creating a transient reducing zone within the boiler above the primary combustion zone. We have coined the term "reburning" in the U.S. to refer to this process, and when using gas as the reburn fuel it appears that the country is capable of reducing $NO_x$ by approximately 50 to 60 percent below the boiler's current emission levels.

Mr. Chairman, I think the real importance of this probably is on the chart on page 8 of my full testimony, where we're talking about the relative cost effectiveness of these strategies. And what this does, this has taken the EPRI table for calculating the cost effectiveness and compares coal cleaning, fuel switching, limestone injection with multi-phased burners, and then gas-enhanced dry sorbent injection, and finally scrubbers.

The important point is that this gas reburn sorbent injection country from the standpoint of the investment cost is on the magnitude of $20 to $25 million, compared to over $100 million for a scrubber.

Secondly, the cost per ton reduction for $SO_2$ and $NO_x$ is on the order of $600 per ton compared to $900 or more sometimes for scrubber technology. So it does appear that it has a chance to be a cost effective application in addition to reducing the pollutants.

We have three sites that have agreed to participated in this program. GRI is contributing $10 million, the State of Illinois is contributing $5 million toward a $30 million overall program over the next three or four years. It is one of nine projects selected by DOE for demonstration in phase one of the clean coal program.

These three sites were picked specifically because each one has a different type of boiler: tangential fired, front wall, and a cyclone coal-fired boiler. These are the primary ones in use in existing applications today.

Initial tests will be conducted using Kentucky and Illinois coals. EPRI is interested in participating in the program and may in fact provide some coal cleaning technology, where we would test additional coals later on in the process.

We think the major market for this is retrofit applications in the Midwestern coal producing states, primarily Kentucky, Pennsylvania, West Virginia, Ohio, Illinois, and Indiana. These states have 47 percent of the total installed capacity.

So it would appear that this is a low capital cost method by which you can reduce the pollutants.

In conclusion, the gas reburn sorbent injection program has the potential to lead to commercialization within four to five years of a cost effective near-term retrofit technology that would allow us to continue to use the local coals, that would provide utilities with the flexibility for them to select the best technology and the best mix of technologies to meet any potential environmental concerns in the most cost effective manner.

It would seem to me that in any future legislation, if there is to be any at all regarding reductions of emissions from $SO_2$ and $NO_x$, we need to really consider that the timetables, if any are established, have got to be far enough out that these technologies that are being demonstrated in phase one of the DOE program, the program that Mr. Bagge was talking about, the program Senator Byrd has proposed, you have got to have time to prove these technologies out so that you can pick the most effective ones.

Secondly, a lot of these technologies will reduce $SO_2$ or $NO_x$ or in our case, this one, simultaneous reduction of $NO_x$ and $SO_2$. There ought to be flexibility in any legislation that allows tradeoffs for $NO_x$ reductions for $SO_2$ reductions. Then you truly are giving a utility manager the flexibility to pick the most cost effective solution for his site, his equipment, the type of coal that he is using, and his particular environmental concerns.

Thank you very much, Mr. Chairman. I appreciate the opportunity to appear here today.

[The prepared statement of Mr. Webb follows:]

# TESTIMONY OF DAVID O. WEBB
SENIOR VICE PRESIDENT, POLICY AND REGULATORY AFFAIRS
GAS RESEARCH INSTITUTE
BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
ENERGY AND NATURAL RESOURCES COMMITTEE
U.S. SENATE
APRIL 9, 1987

I appreciate the opportunity to appear before you today to discuss the important role gas can play as one critical element of a national clean coal program. The role of gas is often overlooked in any discussion of a clean coal technology program, yet documented laboratory research results indicate the use of gas in combination with coal may be the most cost-effective retrofit approach to simultaneously reducing nitrogen oxide ($NO_x$) and sulfur dioxide ($SO_2$) emissions from flue gases. Research sponsored by Gas Research Institute (GRI) over the past three years as part of an Environmental Protection Agency (EPA) research project clearly illustrates that gas-enhanced emission control is one of the most promising near-term clean coal technologies, especially for retrofitting existing coal-fired boilers.

The results from laboratory tests of these technologies are a 60 percent reduction in $NO_x$ and a 50 percent reduction in $SO_2$. The next step is a demonstration of these gas-enhanced technologies in retrofit applications in utility and large industrial boilers. This could occur during the next three to four years as part for the Department of Energy's (DOE) clean coal demonstration program. If the demonstrations are successful, the gas-enhanced emission control processes will provide an extremely cost-effective solution for simultaneously reducing $SO_2$ and $NO_x$ emissions. For this reason, I urge the members to consider the critical contribution gas can pay as part of the solution to clean coal combustion.

GRI fully supports additional funding being made available to DOE for clean coal technology demonstrations, especially for near-term applications that use natural gas in combination with other technologies for flue-gas cleanup and for the longer-term coal gasification applications that would provide one of the most cost-effective methods to clean up our vast coal resources. In the near term, the use of gas in a reburn mode for $NO_x$ reduction and as a transport medium for sorbent injection to reduce $SO_2$ offers the potential for early retrofit in many utility and large industrial boilers. These technologies should be given high priority in any demonstration program.

GRI is an independent, not-for-profit research organization that manages a cooperative research and development program for the gas industry and its customers. The R&D program is implemented through contracts with universities, energy companies, and manufacturers. Even though GRI is not a government contractor, GRI cofunds and coordinates many of its research programs with DOE. GRI is a major cofunder for one of the nine projects DOE selected for the first phase of the clean coal technology program. Therefore, Congress's actions on the FY 1988 DOE budget have a direct impact on the gas industry's research program.

## ROLE OF GAS IN CLEAN COAL TECHNOLOGIES

Federal policy has long overlooked the significant role natural gas can play in helping the nation use coal in an environmentally acceptable manner. In fact, for near-term and many retrofit applications, gas used in combination with coal combustion systems is probably the best solution.

Natural gas is our nation's cleanest fossil fuel. Its combustion emits virtually no particulates, sulfur oxides, or reactive hydrocarbons, and it produces far lower emissions of nitrogen oxides and carbon monoxide per unit of energy than coal or oil. Used selectively with coal, relatively small quantities of natural gas could contribute significantly to protecting our air quality at a low cost. Given the size of the gas resource base and the economics of gas production, the competitive position of gas relative to other environmental control options should remain favorable. In addition, a million-mile pipeline and distribution network is already in place. Thus cost-effective solutions to using coal cleanly are both possible and practical by selectively using natural gas.

Gas can be used in one combustion unit to offset the emissions from dirtier fuels, such as coal, in another unit; it can be used for simultaneous combustion of gas and coal in a single combustor; and it can be used in flue-gas cleanup systems as a transport mechanism for sorbent injection to reduce $SO_2$ and in a reburn mode to reduce $NO_x$. The use of gas as part of the overall approach to controlling flue-gas emissions during coal combustion should be one element of national energy policy.

## THE IMPORTANCE OF EMERGING TECHNOLOGIES

On April 24, 1984, the Secretary of DOE asked the Energy Research Advisory Board (ERAB) to convene a panel to assess the principal technologies for the clean use of coal. The ERAB panel completed its assessment in 1985. These findings are still relevant in any review of the nation's clean coal technology program:

1. Coal use in the U.S. is expected to continue to increase for most of the next 25 years.

2. The two major factors influencing this trend are the low price and the abundance of domestic coal and the reduced contribution of nuclear power.

3. Direct combustion of coal will continue to represent over 90 percent of all coal use for the rest of the century and beyond.

4. The number of specific coal-use situations is so large and diverse, and the specific problems are so site-specific that no generally applicable solution can be presented. This issue is even more difficult when applied to retrofit situations which represent the overwhelming majority of applications.

5. Greater cooperation, particularly between DOE and EPA, and more coordinated funding can speed up completion of R&D programs that are urgently needed.

The ERAB panel made four specific recommendations in its report to DOE that clearly indicate the importance it assigns to emerging clean coal technologies.

1. Early demonstration of retrofit technology is most urgent.
2. Limestone Injection Multistage Burner (LIMB) and improved Flue-Gas Desulfurization (FGD) should be top priorities. Aggressive pursuit of this target will make full deployment possible around 1990.
3. It is important to make sure that the high-sulfur coals that can be mined at a relatively low cost are given priority for the test work. This includes coals from areas such as Kentucky Nos. 9 and 11 seams, Illinois and Indiana Nos. 5 and 6 seams, and Ohio and West Virginia Pittsburgh seams.
4. The basic goal of the research will not be achieved unless we can apply new processes to the high-sulfur coals.

Federal policy has long overlooked the significant role natural gas can play in helping the nation use coal in an environmentally acceptable manner. Therefore, it is particularly encouraging to GRI and the gas industry that ERAB emphasized the urgency of demonstrating flue-gas cleanup for both $NO_x$ control and to assist in $SO_2$ control in its report to DOE. In fact, for many near-term retrofit applications, gas used in combination with coal in both industrial and utility combustion systems has the potential to be the most cost-effective solution.

**GAS-ENHANCED DRY SORBENT INJECTION AND REBURN**

Concern over acid precipitation has created an incentive for government and industry to develop more cost-effective technologies to control $SO_2$ and $NO_x$ emissions from coal and oil combustion, particularly in utility and large industrial boilers.

GRI and the EPA have been funding the Energy and Environmental Research Corporation (EERC) of Irvine, California, to develop gas reburn and gas-enhanced dry sorbent injection technology to control $SO_2$ and $NO_x$ emissions from coal and oil combustion. GRI's focus has been to examine control of $NO_x$ and $SO_2$ emissions from coal combustion by incorporating two developing gas combustion technologies which can be applied individually or as an integrated element of a flue-gas cleanup system.

1. Reburn Technology. Use of natural gas as a reburning fuel to create a reducing zone above the primary combustion zone to reduce $NO_x$ emissions.
2. Sorbent Injection Technology. Use of natural gas to enhance the capture efficiency of reactive sorbents for improved $SO_2$ reduction.

GRI's project with EPA began in April 1984 and expanded EPA's original focus on coal-fired reburning/sorbent injection at EERC to include an evaluation of the additional benefits (for example, cost reduction, increased emissions control, boiler operation improvements, etc.) obtainable from the use of gas as the reburning fuel.

Sulfur dioxides can be controlled by removing sulfur from the fuel or sulfur dioxides from the products of combustion. However, current methods such as scrubbers or coal cleaning generally are capital intensive with high operating and maintenance costs, or they do not provide the necessary degree of $SO_2$ control.

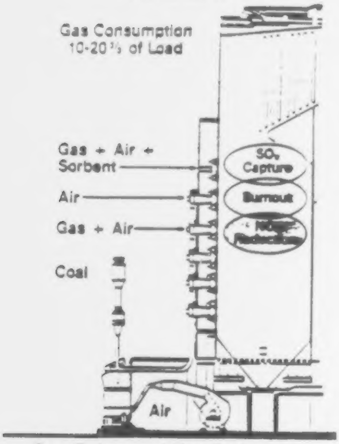
One of the more promising $SO_2$ control strategies is to inject calcium-based sorbents into the combustion chamber to capture the sulfur prior to the boiler outlet. This process was investigated in the late 1960s and was abandoned because it could not achieve the desired $SO_2$ control and also tended to create operational problems. Recently, there has been sufficient incentive to reexamine the limestone injection process (LIMB) as a cost-effective retrofit alternative for acid rain precursor control. The EPA's efforts in recent years have focused on the development of this technology for coal-fired boilers.

GRI's program with EERC has been to enhance the cost-effectiveness of this technology through the use of gas combustion technology. Gas may offer improved sorbent injection performance benefits by more effectively controlling the conditions at which limestone sorbent is calcined and mixed with the coal combustion flue gases; it may help to avoid coal-ash/sorbent interaction problems that decrease sorbent surface area; it can be used more effectively to optimize the temperature profile of the sulfation zone where sulfur capture occurs; and it reduces the amount of sorbent material needed.

Nitrogen oxide emissions are also considered, although historically to a lesser extent, as a contributing factor to acid deposition. The attention to $NO_x$ as an acid deposition processor is increasing as scientific evidence tends to indicate that both $SO_2$ and $NO_x$ are contributors. The formation of $NO_x$ during the combustion of fossil fuels can be minimized by appropriate modification of the combustion process.

Recently, the Japanese have introduced a new $NO_x$ control strategy which involves in-furnace $NO_x$ reduction by creating a transient reducing zone within the boiler. EPA has been conducting research programs to evaluate the potential of this technique for application to U.S. boilers. The term "reburning" has been coined in the U.S. to refer to this process. When using gas as the reburn fuel, it appears that this technology is capable of reducing $NO_x$ by approximately 50 to 60 percent beyond a boiler's current emission levels. The specific technical benefits of using gas as the reburning fuel are that gas can be broadly retrofitted to existing boilers and can be applied without the combustion problems associated with coal firing in upper boiler regions; gas allows lower exhaust $NO_x$ emission levels to be achieved since it is nitrogen free; and gas avoids the presence of molten ash in the superheater boiler region, thereby minimizing slagging and fouling problems.

# GAS APPLICATIONS RESEARCH



Gas Enhanced Dry Sorbent Injection
Plus Gas Reburn -
$SO_x/NO_x$ - Control

Potential benefits of gas use are both environmental and economic. The development of more cost-effective $SO_2$, $NO_x$ and combined $SO_2/NO_x$ control technologies using gas would lower energy costs and improve air quality. The economic benefits are broad based and provide an alternative to high-cost flue-gas scrubbing technologies. In addition to the significant $NO_x$ and $SO_2$ reductions, boiler operators may also realize substantial operating benefits (mitigation of boiler derating, particulate control, and reduction of availability problems, etc.) by implementing gas-enhanced reburn/sorbent injection techniques. Furthermore, the gas-enhanced technologies would increase our ability to use the nation's natural resources and would decrease our dependency on imported oil. The environmental payoff is a significantly reduced quantity of pollutants emitted by coal or oil burning.

Specific elements of the joint EPA/GRI research program that GRI funds are detailed on the following pages.

Gas Reburn--$NO_x$ Control

1. GRI's initial research goal is to develop gas reburn technology for $NO_x$ control and to integrate gas reburn and boiler sorbent injection technologies for combined $NO_x$ and $SO_2$ control.

2. The reburn research focus is to determine the optimum conditions and gas injection techniques to create fuel rich reburn regions for $NO_x$ reduction.

3. Coal is burned as the primary fuel in the lower portion of the boiler under conventional conditions with the reburn gas (10 to 20 percent of total boiler fuel input), and burnout air is injected in the higher sections of the boiler.

4. Research results to date from pilot scale testing indicate that $NO_x$ emissions can be reduced significantly (greater than 50 percent) when small amounts of gas are fired in reburn fashion.

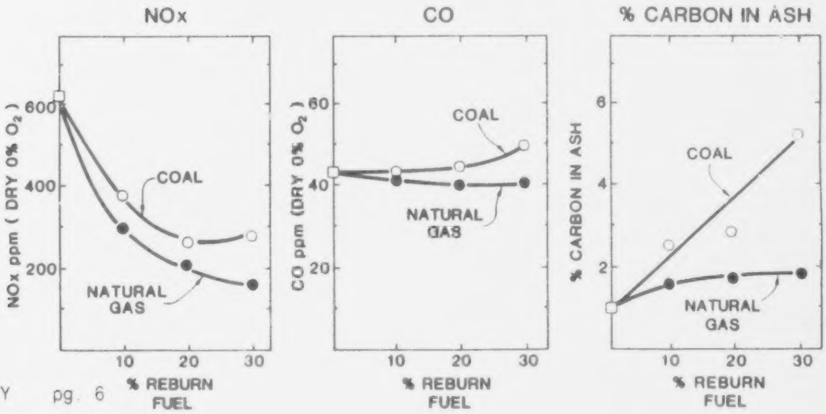
5. Compared to coal as the reburn fuel, gas is more effective in $NO_x$ reduction; requires shorter reaction time; does not present operational problems such as carbon burnout, slagging, etc.; and simultaneously reduces $SO_2$ and particulate matter.

6. In addition to lower $NO_x$ levels, gas reburn may be easier to retrofit than low-$NO_x$ burners. For some boiler configurations, low-$NO_x$ burners are not commercially available.

The advantages of gas versus coal as a reburn fuel are illustrated below.

COMPARISON OF THE EFFECTIVENESS OF GAS
AND COAL AS REBURN FUELS.

( PRIMARY FUEL : COAL ; SCALE : $10 \times 10^6$ Btu/hr )



Gas-Enhanced Dry Sorbent Injection--$SO_2$

1. Simultaneously, GRI is funding research to use natural gas to enhance $SO_2$ control. This research is focused on both combining reburn technology with sorbent injection where there is a $SO_2$ reduction proportional to the amount of gas reburn fuel used and developing gas-enhanced sorbent preparation and injection techniques where gas is used to increase sorbent reactivity and utilization.

2. If successful, GRI's research will improve the cost-effectiveness of LIMB by reducing sorbent expenses and increasing $SO_2$ capture. More importantly, use of gas will lower the solids loading within the boiler and particulate control system.

3. Critical technical issues regarding sorbent injection are the quantity of sorbent material in boiler convective sections and entering electrostatic precipitators, calcination of sorbent to maximize surface area, protection of sorbent from sintering, and rapid mixing of sorbent with coal combustion flue gases within the temperature window (1750°F to 2250°F) for $SO_2$ capture.

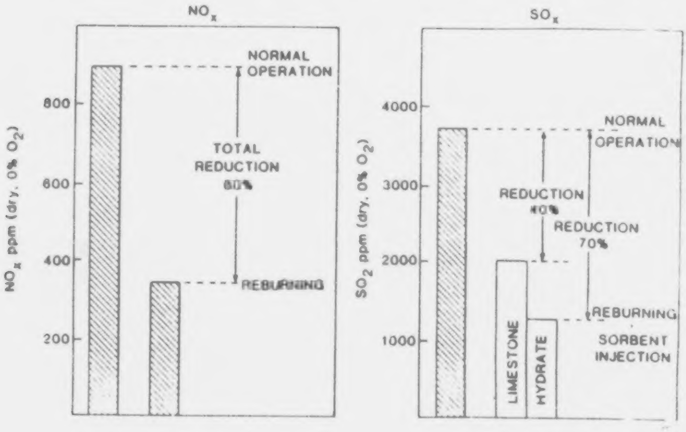
4. The relatively uniform composition and ease of handling makes natural gas the ideal fuel for resolving the critical technical issues and for enhancing the effectiveness of $SO_2$ removal.

5. Potential benefits of this research would be an improvement in the cost-effectiveness of LIMB technology and potentially broader applicability.

6. Total gas fuel requirements for combined gas-enhanced reburn and sorbent injection technologies are estimated to range from 15 to 20 percent of the total boiler fuel input.

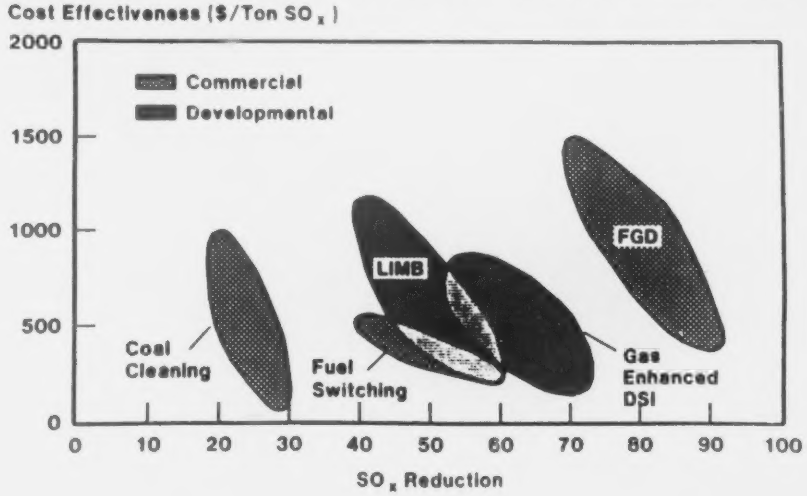
An illustration of the effectiveness of using natural gas to enhance flue-gas cleanup options is shown below.

GAS REBURNING-SORBENT INJECTION EFFECTIVENESS
PRE-NSPS BOILER FIRING HIGH SULFUR COAL



The following figure is a graphic display of the range of DOE and EPA cost-effectiveness data available from the literature for each technology. The figure also shows the improved performance goals for gas-enhanced Dry Sorbent Injection (DSI) technology relative to LIMB. Of the technologies considered in the figure, only LIMB with low-$NO_x$ burners and gas-enhanced DSI plus gas reburn provide for both $SO_2$ and $NO_x$ control. Gas reburn achieves lower $NO_x$ levels. The basis for these cost comparisons are presented in the attached Tables 1 and 2.

## RELATIVE COST EFFECTIVENESS OF ALTERNATIVE ACID PRECURSOR CONTROL STRATEGIES - $SO_X$



To summarize, gas has the unique advantage of allowing the simultaneous application of reburn and sorbent injection technologies in the same boiler. Over the next five years, GRI plans to spend over $5 million to support research and development of the reburn/sorbent injection technology for application to industrial and utility boilers. By using natural gas to enhance reburn/sorbent injection technology, GRI's goal is to provide greater than 60 percent $NO_x$ and 50 percent $SO_2$ emission reduction while offering cost advantages over competing wet scrubbing technology. Different technology variations are being explored at both bench and pilot scales. The next step is to initiate full-scale testing of reburn technology and gas-enhanced sorbent injection technology starting in 1987.

## OVERVIEW OF THE GR-SI DEMONSTRATION PROGRAM

The EERC proposal "Enhancing the Use of Eastern and Midwestern Coals by Gas Reburning-Sorbent Injection" was one of nine selected by DOE for demonstration in Phase I of the clean coal technology program. The estimated total cost of the program to demonstrate gas reburning-sorbent injection (GR-SI) is $30 million over three to four years. GRI will provide $10 million, and the Department of Energy and Natural Resources of the State of Illinois will cofund $5 million. Also, EPRI has expressed interest in the program and may provide the use of certain equipment and facilities at no cost.

Three host sites (see Table 3) have agreed to participate in the program. These sites will provide full-scale, operational demonstrations in tangential, front-wall, and cyclone coal-fired boilers, which are typical of pre-NSPS designs. These types of units produce 12 million tons of $SO_2$ per year. Initial tests will be conducted using Kentucky and Illinois coals. Plans are being considered for testing other coals. Each host site will be tested for a range of conditions culminating in a one-year long-term evaluation. All data and test results will be compiled into a guideline manual which will be made available to industry.

Each host site will be considered separately based on its unique design parameters, operating history, and performance requirements. A field test will be conducted to quantify performance and emissions over the normal duty cycle. EERC will select a technology combination for each site which meets the emissions control and performance objectives at minimum total cost. Once these plans have been approved by DOE, the GR-SI hardware will be installed and tested prior to the beginning of the technology demonstration. The demonstration will include:

1. Optimization testing to determine the conditions which provide the best overall balance of performance.

2. Evaluation of alternate coals and sorbents to extend the data base on the technology. The tests will include the use of a cleaned coal.

3. Long-term evaluation of the GR-SI technology to assess impacts on boiler efficiency, slagging/fouling, carbon loss, convective pass erosion, auxiliary power consumption, precipitator performance, and ash disposal requirements as well as other site-specific factors.

4. Economic evaluation according to the EPRI Technology Guide (TAG) procedures.

5. Preparation of a Design Guideline Manual.

The objective of this project is to provide a comprehensive data base demonstrating the applicability of GR-SI when applied to pre-NSPS utility boilers and to promote commercialization. Rapid commercialization of GR-SI, once its performance has been verified, is possible because the infrastructure is already in place to apply the retrofit technology. A&E firms and boiler manufacturers will be in a position to commercialize the technology. This program will provide the technical basis. The major market for GR-SI is in the eastern and midwestern coal-producing states: Kentucky, Pennsylvania, West Virginia, Ohio, Illinois, and Indiana. These states have 47 percent of the total installed boiler capacity, or a little over 88,000 MW. GR-SI is a low-capital-cost technology, and it has a significant market niche for existing boilers in the 100 MW to 300 MW range. Therefore, GR-SI represents a potential near-term, cost-effective, environmentally acceptable solution to burning high-sulfur bituminous coal.

## CONCLUSION

In conclusion, this GR-SI demonstration program has the potential to lead to the commercialization of a cost-effective, near-term retrofit acid rain precursor control technology. This technology will encourage the use of local coals and will provide the utilities with the flexibility to meet pollutant emission regulations with the fuel of choice at the least cost to the consumer.

Any future legislation that mandates reductions in emissions of $SO_2$ and $NO_x$ from coal must contain the necessary flexibility and trade-offs of substituting $NO_x$ reductions for partial credit against $SO_2$ reductions to allow industry to use these emerging technologies. Without this flexibility, years of federal and industry research efforts and taxpayer dollars will be wasted. More importantly, the most cost-effective solutions will not be available as options. This will increase the cost of electricity for all consumers.

Mr. Chairman, that completes my testimony. I sincerely appreciated the opportunity to present this testimony to your Subcommittee.

Table 1

### BASES FOR ECONOMIC COMPARISONS OF $SO_x$ and $SO_x/NO_x$ RETROFIT CONTROL TECHNOLOGIES FOR POWER PLANTS

500 MW Rated Capacity -- Wall-Fired Boiler
Capacity Factor = 0.6
Coal Characterisitcs: 2.5% Sulfur
12.5% Ash
11,500 Btu/lb
15-Year Levelization Period
Flue Gas Desulfurization at 90% $SO_x$ Removal
Natural Gas Reburn/Dry Sorbent Injection at 60% $NO_x$ and 50% $SO_x$ Control
15% Gas of Total Boiler Fuel
Gas Fuel Price Premiums of $1 and $2 per Million BTU Compared to Coal
EPRI Cost Guidelines
1986 Dollars

Table 2

### COMPARISON OF COSTS OF $SO_x$ and $SO_x/NO_x$ RETROFIT CONTROL TECHNOLOGIES FOR 500 MW WALL-FIRED BOILER

| | Investment Cost | | Levelized Annual Cost | | Emission Reduction | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1000 Tons/Yr | | Cost, $/Ton | |
| | $Million | $/KW | $Million/Yr | Mills/KWH | $SO_x$ | $NO_x$ | $SO_x$ | $SO_x/NO_x$ |
| Flue Gas Desulfurization | 108 | 216 | 43 | 16 | 50 | 0 | 860 | 860 |
| Natural Gas Reburn/ Dry Sorbent Injection | | | | | | | | |
| $2/Million BTU Premium | 24 | 48 | 26 | 10 | 28 | 7 | 925 | 740 |
| $1/Million BTU Premium | 22 | 45 | 21 | 8 | 28 | 7 | 750 | 600 |

Table 3

CHARACTERISTICS OF HOST SITES

| | | | |
|---|---|---|---|
| **GENERAL** | | | |
| UTILITY | ILLINOIS POWER | CILCO | CWLP |
| STATION, UNIT | HENNEPIN, 1 | EDWARDS, 1 | LAKESIDE, 7 |
| LOCATION: STATE | ILLINOIS | ILLINOIS | ILLINOIS |
| CAPACITY (MW) | 80 | 117 | 40 |
| **BOILER** | | | |
| FIRING CONFIGURATION | TANGENTIAL | FRONT WALL | CYCLONE |
| CAPACITY ($10^3$ lb/hr) | 585 | 850 | 320 |
| MANUFACTURER | CE | RILEY | B&W |
| **PRECIPITATOR** | | | |
| LOCATION | COLD SIDE | COLD SIDE | COLD SIDE |
| SIZE (SCA) | 223 | 137 | 333-1000 |
| MANUFACTURER | BUELL | AMERICAN STANDARD | SMIDTH |
| **FUEL** | | | |
| COAL TYPE | ILLINOIS, BIT | BLEND<br>ILLINOIS, BIT<br>KENTUCKY, BIT | ILLINOIS, BIT |
| SULFUR (%) | 3-8 | 1.0 | 3.8 |
| GAS AVAILABILITY | YES, 100% | 4 MILES | ON SITE |
| **EMISSIONS CONTROL APPROACH** | | | |
| NO$_x$ APPROACH | GAS REBURNING | GAS REBURNING | GAS REBURNING |
| CONTROL (%) | 60 | 60 | 60 |
| SO$_2$ APPROACH | UPPER FURNACE INJECTION | UPPER FURNACE INJECTION | DUCT INJECTION |
| CONTROL (%) | 50 | 50 | 50 |
| ESP ENHANCEMENT | HUMIDIFICATION | HUMIDIFICATION<br>SO$_3$, INJECTION | NONE |

Senator FORD. Thank you very much, Mr. Webb.

I want to limit my questions to each individual, and it may be that one or the other would like to take exception or endorse the other one's statement. Why, it will be all right.

Mr. Bagge, you referred to your experience, previous experience. And what can we do to influence the state public utilities commissions to work, as you stated in your overview of your full statement? What federal regulatory changes would help solve the problem, or should we even get into that?

You talked about persuasion, I think, a few moments ago. But sometimes that does not work around here.

Mr. BAGGE. Well, you know, my experience, six or seven years in the Federal Power Commission, was that where we adopted policies, where the old Federal Power Commission, now FERC, adopted regulatory policies to the extent to which we had jurisdiction over the wholesale sales between and among the utilities, it had a precedential effect on the PUC policies throughout the states. That's one thing.

On very sensitive issues such as handling—very controversial and highly politically sensitive, like tax policy, how tax policy was implemented in the context of regulated utility sector, it was persuasion.

But here in the Byrd bill, it seems to me he goes beyond that, because he mandates in the bill the prudency test, which is a stumbling block. This is the ultimate institutional inhibition to making—you know, taking conservative utility managers, who have to be conservative by nature because they've got to protect their shareholders" investment.

But beyond persuasion, I think the bill opens up, by addressing the federal prudency test with respect to one of these projects, it goes beyond that and it says the state PUC's ought to be involved initially, because you're not going to make a grant, that the Department of Energy in authorizing, the funds that Congress hopefully will provide here under this program will not be allocated without the prior signoff of the PUC and involving the PUC intellectually in the process of the commitment.

Now, that to me is unprecedented and a breakthrough, it seems to me, in our effort to try to get national policy implemented throughout the states. So I take a lot of comfort from the methodology, let me just say, that's provided in Senator Byrd's bill, by involving the state PUC's before the federal grant as a condition precedent.

To me that's the touchstone and that's the magic, if you don't mind my using that term, which will break the logjam between the traditional fear of federal intervention in state PUC policy.

I hope that answers your question. But I think he's touched the—he's broken the code, to put it in the vernacular.

Senator FORD. We found magic here this morning.

Mr. BAGGE. I found it, right. Senator Byrd always provides the magic. [Laughter.]

Senator FORD. Mr. Bagge, would you comment on the maturity of the various clean coal technologies and give some kind of a projection when you believe that they will be ready for commercialization through a deployment program?

Mr. BAGGE. Senator, I'm no technician and I don't pretend to be, and I'm really not competent to answer that question in any intelligent technical way, except to say it's my hope that—you know, we have projects that, even apart from this program, are ongoing now in several.

I have the Black Dog project, NUCLA, where the coops have done this. Commitments have been made already in some areas. But you see, these aren't going to be operative for the next four or five years, even as demonstrations. So that you're talking about a technology that isn't going to be demonstrated for another at least three to four to five years, possibly.

And to ask me when the utility industry, if we can come to grips with the institutional constraints with the PUC's and resolve that problem, and when we can do this, it has to be late in the 1990's, it would seem to me as a layman, and maybe in the next century.

To make them fully commercially viable projects, where a board of directors would authorize and the PUC would consent to a major commercial project has to be in the late 1990's. But this is the nature of the system we're dealing with. There are no quick fixes for these problems.

Senator FORD. I have always been one who thought you ought to go ahead and build some even if they were white elephants, and just move on, because you may luck out. We have been so very careful in our approach and continue to wait for new technologies to come on board, then we want to wait a little while and see how we get to newer areas, and then well, if we go ahead and put it in now by the time you get it installed it will be obsolete—well, if it was obsolete we still haven't put it on the board.

So I am for moving on. But I am restrained in this body around here that you cannot move fast, you have to study it and study the darn thing to death. You have to funnel out some more money for more research and development.

I know and I understand that, but at some point you are just going to study it to death and the paper is going to be thin from turning the pages and we have to move on.

Mr. BAGGE. It'd be ideal if we could. But we're talking about capital that has to be returned to the shareholders.

Senator FORD. Oh, I understand that.

Well, based on what you have just said—and maybe this does not have to have the technical expertise that you think you have in making your judgment on the earlier question—should the clean coal program be targeted now to retrofit projects only, or should it be expanded to include new generation technologies, as suggested by the man who produces the magic?

Mr. BAGGE. I think, you know, I must say that unless we do both we are missing out. I tried to say in my informal comments that we're at a crossroads. Coal, the utility industry, we are really literally at a crossroads right now.

We haven't built the generating capacity in the last decade. We're looking at shortages in the 1990's. And unless we position ourselves now so that we can do both, we're going to be missing the real fruits that ought to flow from this national commitment.

Senator **Ford**. Critics have argued that we need emission reduction targets or the clean coal projects developed will not be used. Do you believe this is a valid criticism?

Mr. **Bagge**. No. I tried to deal with that both in my formal——

Senator **Ford**. I know that, but I want to ask that specifically.

Mr. **Bagge**. No, the real dimension to me that really distinguishes this concept, this whole program, from anything else that I've seen in the 17 years that I've been praying over coal is that this stands on its own.

The very fact that you can achieve thermal efficiencies, you can reduce the cost of maintenance, and you can reduce operating costs, which is about to be demonstrated now in two sites that I'm personally aware of right now in the area of fluidized bed, makes the program stand on its own.

You don't need the intervention of government or the ham-handed hand of regulators mandating that the utility industry achieve a certain level of $SO_2$ emissions within a short period of time, because then they have to be forced to go to the old technology.

This will be totally self-defeating. What I'm making is two points, Senator: the program stands by itself as a self-operative, economically viable program, totally apart from the politics of acid rain; and secondly, that if you do as a matter of national policy force the utility industry into taking quick action now, they're going to be locked into the old technologies.

You won't have this demonstration or the implementation of this program, and they won't have the option of making leapfrogging to the new technologies. I think it would be disastrous for both these reasons.

Senator **Ford**. If we would force present utilities to meet certain standards and the only alternative is to move to scrubbers, we've heard about efficiency and how scrubbers would reduce the efficiency from the Secretary a moment ago.

Mr. **Bagge**. Right.

Senator **Ford**. Do you not think that scrubbers will increase the inefficiency and increase the cost, because if you are required to put a scrubber on a present utility that is several years old that the scrubber will require them to carry it on much beyond the 30 or 35 years lifetime that is normally prescribed?

Mr. **Bagge**. Indeed, exactly. And you're locking the utility industry into that primitive, if I can use that characterization—it is a primitive—technology that was evolved in response to the decade of the seventies, the enactment of the Clean Air Act in 1970. That's a primitive technology.

We're locked into it and this affords us an opportunity to break through and make efficiencies. And I couldn't agree—if that's a question or a statement—I agree with the statement you made, and if it's a question I applaud, I say I agree with it, because it would be a tragic blunder if we did this as a nation to ourselves. It would be shooting ourselves in the foot.

Senator **Ford**. Let me ask you. On page 5 of your testimony you speak to the scientific evidence that refers to—that demonstrates the acidic precipitation issue is not as severe or as widespread as originally believed. Would you supply the Committee with those documents for the record?

Mr. BAGGE. I'd be very happy to. But I'd also, if you don't mind my saying, that there is a critical document, the joint report to the bilateral advisory group between Canada and the United States on the status of Canadian-U.S. research on acidic deposition, that was released only yesterday, and which I think is a most significant document.

Unfortunately, it was not released publicly before the President was up in Ottawa talking to Prime Minister Mulroney. It was released only yesterday.

And that document, among other things, points—and it's the Canadians working with us. The document points out that we have in fact reduced the emissions by over a million and a half tons in the states bordering on Canada in the recent few years, that $SO_2$ emissions are declining.

And the politically significant part of this study is the fact that the Canadian scientists participated in the study. Now, this unfortunately didn't make the press, which I think is tragic from my point of view, because it wasn't released until after the Reagan-Mulroney meeting in Ottawa. It was released publicly only yesterday.

But that to me and other documents that have been recently released by both Canadian scientists, both Canadian scientists and United States scientists, are pointing out that our calibrations of our instruments were inaccurate, and what we perceived to be a problem, as a large problem, now, what they're saying now—and the evidence is accumulating weekly—that it isn't as large as we perceived it to be originally.

And these are scientists in Canada as well as the United States. I'll be delighted to provide copies of that for the record.

Senator FORD. We have a copy of that already and we put that in the record.

The other evidence that you have is very valuable to us, too, Mr. Bagge.

[The information follows. Documents referenced in the April 21, 1987, letter have been retained in subcommittee files.]

NATIONAL
COAL
ASSOCIATION

COAL

CARL E. BAGGE
President
(202) 463-2647

April 21, 1987

The Honorable Wendell H. Ford
Chairman, Subcommittee on Energy
Research and Development
United States Senate
312 Hart Senate Office Building
Washington, D.C. 20510

Dear ~~Mr. Chairman~~ Wendell:

During my testimony on April 9th before the U.S. Senate Energy and Natural Resources Committee, Subcommittee on Energy Research and Development which you chaired, I noted that scientific evidence continues to demonstrate that acid rain is not as severe or widespread as originally believed, is not irreversible and does not pose an immediate threat.

You requested that the documents to which I referred be supplied for inclusion in the record of the hearing. I believe the three attached documents support my testimony and represent recent research dealing with acid rain.

I. Joint Report To Bilateral Advisory and Consultative Group (US/Canada) entitled, Status of Canadian/US Research in Acidic Deposition - February 25, 1987.

II. Reevaluation of Trends in Surface Water Alkalinity in New York and New Hampshire - James R. Kramer Ph.D McMaster University. Hamilton, Ontario-October, 1986.

III. The evolving science of acid deposition - Joan P. Baker Ph.D., Kilkelly Environmental Associates Inc., Raleigh, N.C. - March, 1987

Since each document addresses different aspects of the issue, the following is provided as a brief insight into the separate findings of each report.

I. The Joint Report entitled, "Status of Canadian/US Research in Acidic Deposition", represents the first statement of progress on the scientific research related to transboundary air pollution currently being conducted by U.S. and Canadian scientists.

1130 Seventeenth Street, N.W.
Washington, D.C. 20036-4677

(202) 463-2625

The major part of the report consists of new scientific information developed subsequent to the data base used in producing the Special Envoys Report. The report includes extensive findings and recommendations for further discussion and/or additional research.

Highlights of the findings include:

* In Eastern states bordering Canada, emissions of $SO_2$ have declined by about one million tons from 1980 to 1985.

* Dose/ response experiments in laboratory and field grain crops show no significant reduction in yield over a wide variety of species when exposed to simulated acidic deposition experienced in Eastern North America.

* While US and Canadian researchers disagree regarding growth reduction induced by simulated rain, the report states that, at present, after review of several survey observations it cannot be demonstrated whether or not acidic deposition is a factor and points out that natural stresses and air pollution have been proposed as causative factors in certain observations.

* The report points out that in the region of the Northeast showing the highest percentage of acidic lakes, the Adirondacks, only 10% were acidic and that this 10% represented but 1.6% of the total lake area. The Western lake study found only one acidic lake fed by an acidic hot spring.

II. Dr. Kramer's report entitled, "Reevaluation of Trends in Surface Water Alkalinity in New York and New Hampshire", looks at the historical and recent alkalinity data from surface waters in two of the regions of the Northeast where it has been claimed that the surface waters have increased in acid content over the last 50 years.

The study looked at the methodology used by previous researchers to assess trends in acidity in the two states. The reevaluation was necessary because of differences between historical and current methodologies - differences that have precluded accurate trends assessment. Recent developments allow historical data to be corrected so that accurate quantitative comparisons can be made.

The author found that previous researchers in comparing historical data did not allow for the fact that colormetric techniques used at that time for measuring alkalinity and ph, when used in waters like New York and New Hampshire, yield erroneously high values for both alkalinity and ph. New techniques are more accurate and when coupled with work of other researchers yielded the following results.

In New York: the raw uncorrected data for the 211 lakes surveyed showed that 18 lakes (9%) experienced no change in alkalinity, 13 lakes (6%) increased and 180 lakes (65%) decreased in alkalinity over a 50 year period. Once the data was corrected, the results changed dramatically: 90 lakes (43%) experienced no change in alkalinity, 67 lakes (32%) increased and 53 lakes (25%) decreased in alkalinity. Similar results were found in New Hampshire where corrected data shows 79 lakes (69%) with no damage in alkalinity, 28 lakes (29%) increased in alkalinity and only 8 (7%) decreased in alkalinity.

This quantitative comparison produced two findings. First, between 43% and 69% experienced no change in alkalinity and second, more lakes experienced an increase in alkalinity than a decrease. The author states that these two findings suggest that the acidic content of these lakes has undergone no more than natural variability.

Dr. Kramer is associated with the Department of Geology at McMaster University in Hamilton, Ontario.

III. Dr. Baker's report entitled, "The Evolving Science of Acidic Deposition", challenges the speculations of the late 70's; namely that acid deposition was causing immediate widespread and potentially catastrophic damage to the environment. The report explains that scientific research has already proven many of these initial claims wrong or greatly exaggerated. Dr. Baker's work reinforces similar conclusions reported in 1983 by the Federal Natural Acid Precipitation Assessment Program (NAPAP) which noted that initial speculation about acid deposition may have been over-simplified, unrealistic or incorrect.

The report addresses 16 topics. It presents the issue, the initial claims, the current state of knowledge and future research plans. In noting that the progress achieved thus far by acid deposition research has been impressive, Dr. Baker points out that "research results to date do not support early claims regarding alleged severe adverse effects of acid rain".

Some examples of these findings include:

* Analyses of historical data do not support the claim that the acidity of precipitation has increased over the past 20-30 years. Recent data (since 1978) indicates no damage from precipitation acidity in the Eastern U.S..

* Current levels of acid precipitation have no significant effect on crop productivity, yield or value.

* Major biological processes and functions are relatively robust and unaffected at current levels of acid deposition.

* Research to date has failed to establish a causal linkage between acid deposition and increased health risks or increased treatment costs associated with public drinking water supplies.

The Honorable Wendell H. Ford
April 21, 1987
Page Five

Dr. Baker, a senior scientist with KilKelly Environmental Associates, is a prominent scientist in the field of research on the effects of acid deposition. She served from 1982-1985 as Natural Research Manager for Aquatic Biota Research under NAPAP and Aquatic Research Coordinator at North Carolina State University.

Dr. Baker has authored over 20 reports and peer-reviewed papers on acid deposition.

Should additional studies and reports become available, I will forward them to your Subcommittee for its review.

Sincerely,

Carl

Carl E.Bagge

Enclosures (3)

# JOINT REPORT

# TO

# BILATERAL ADVISORY AND CONSULTATIVE GROUP (BACG)

## Status of Canadian/U.S. Research in Acidic Deposition

Acid Precipitation
rogam (NAPAP)
l-Provincial Research
Coordinating Committee (RMCC)

February 25, 1987

February 25, 1987

Mr. John D. Negroponte
Assistant Secretary
Bureau of Oceans, International
Environmental and Scientific Affairs
Room 7831 Department of State
Washington, D.C. 20520

Mr. Donald W. Campbell
Assistant Deputy Minister
United States Branch
External Affairs
125 Sussex Drive
Ottawa, Ontario K1A 0G2

Dear Messrs. Negroponte and Campbell:

At the last meeting of the Bilateral Advisory and Consultative Group (BACG) in Ottawa on June 17, 1986 you charged the RMCC and NAPAP to periodically provide a statement of progress in the scientific research related to transboundary air pollution.

Enclosed is the first Joint Report on the Status of Canadian/U.S. Research in both Canada and the U.S. in Acidic Deposition. It encompasses current research programs, the specific response by the U.S. to the research recommendations of the Special Envoys, the current and planned joint research projects, and a list of "new findings" subsequent to the assembly of information for the Special Envoys' report. It is anticipated that each of the future NAPAP/RMCC reports will update the list of new findings.

Where lack of agreement exists on a topic, we have agreed that it shall become an active subject for further discussion and/or planning of additional research. We believe this process of communication as well as the ongoing production of new information will steadily enlarge the scientific data base in the causes and effects of acidic deposition, and thereby enhance the potential for rational and efficient control strategies.

Trusting this is responsive to your request,

Sincerely,

J Laurence Kulp
J. Laurence Kulp
Director of Research
U.S. National Acid Precipitation
Assessment Program

Ferguson
Howard L. Ferguson
Assistant Deputy Minister
Environment Canada
Cochair, Federal Provincial Research
and Monitoring Coordinating Committee

JWGiles
J. Walter Giles
Associate Deputy Minister
Ontario Ministry of the Environment
Cochair, Federal Provincial Research
and Monitoring Coordinating Committee

February 25, 1987

## EXECUTIVE SUMMARY

This is a joint report by the U.S. National Acid Precipitation Assessment Program (NAPAP) and the Canadian Federal-Provincial Research and Monitoring Coordinating Committee (RMCC), the coordinating bodies for the scientific research directed toward understanding acidic deposition related to transboundary fluxes of $SO_2$, $NO_x$, VOC and their associated acids and oxidants. Its purpose is to summarize for the BACG the ongoing research program of both countries, including research specifically aimed at issues raised in the Envoys report, the joint projects, and the significant new additions to the scientific findings.

Joint research projects were initiated in the 70s. Currently, there are 21 joint projects (Table 1) distributed in areas of Forest Effects, Aquatic Effects, Atmospheric Transport, Deposition Monitoring, and Effects on Materials. Particular emphasis has been placed on intercalibration of sampling and laboratory analysis so that results are consistent across North America. Mutual support and full exchange of data exists in areas of acidic deposition and air quality monitoring, cloud chemistry at high elevation in the Applachian mountain chain, material samples at test sites, national emission inventories, cross-continent tracer experiments, and surface water chemistry surveys.

At the joint RMCC/NAPAP meeting in Washington, DC on November 25, 1986, several potential new joint projects were identified: (1) Cause of sugar maple decline, (2) Chemical composition of ground level fogs, (3) Intercomparison of sites for dry deposition. Joint participation in the formal peer reviews of completed or continuing programs was established.

The major part of this report consists of a summary of new scientific information developed subsequent to the data base used in producing the Special Envoys Report. Highlights of the "New Findings" are as follows:

1. Emissions - In the eastern states bordering Canada, which make the largest contribution to transboundary flux the emissions of $SO_2$ have declined by about one million tons (10%) from 1980 to 1985.

   $SO_2$ emissions in eastern Canada decreased by 45 percent from 1970 to 1984 in response to a series of increasingly stringent emissions regulations.

2. Atmospheric Chemistry - Studies around Philadelphia, PA during selected storm events showed that nitrate and sulfate deposition were significantly elevated downwind from the urban area and that low concentrations of oxidants in winter limit the production of sulfate and nitrate from $SO_2$ and $NO_x$.

3. Atmospheric Modeling and Transport - Large-scale experiments with inert tracers showed that simple trajectory long-range transport models can reproduce the movement of air parcels well for at least the first 24 hours in the absence of storms.

   Canada and the U.S. evaluated the performance of eleven linear sulfur atmospheric chemistry models. In comparing observed deposition with predicted patterns, the models did not reproduce secondary peaks, and displaced the maxima by several hundred kilometers. However, given the low discriminating power of the test, the differences between observed and predicted patterns were generally not significantly different over most of the area.

4. Deposition Monitoring - On the basis of preliminary analyses of CANSAP-APN and NADP data for the eastern half of the continent, changes in anthropogenic emissions during the period 1979-1982 are not readily apparent; concentration changes from year-to-year occur concurrently in both anthropogenic and natural constituents and are thought to be more strongly affected by meteorological rather than emissions changes during this period.

Preliminary estimates suggest that dry deposition ranges from 14 to 26% of the total deposition of sulfur in remote locations. The contribution may be up to 40% nearer emission sources.

5. Cloud Chemistry - Wintertime cloud chemistry at Whiteface Mountain, NY shows low concentrations of oxidants leading to higher $SO_2$ and $NO_x$ and less acid than in the summertime. Summer hydrogen peroxide levels are in the thousands of parts per billion and may account for most of the acid formation.

Ozone concentrations in clear air at Whiteface Mountain are about twice as high in May-June as in December-January.

6. Aquatic Effects - Sulfate and acidity decreased in twelve Nova Scotia and eight Newfoundland rivers between the early 1970's and the early 1980's consistent with decreased emissions in the eastern U.S. and Canada.

From the early 1960's through 1983, two benchmark streams in the northeast showed sulfate concentrations down and alkalinity up. In addition, regression analysis suggests that a reduction in regional emissions would lead to a nearly proportional reduction in stream sulfate yield.

The Eastern U.S. Lake Survey of areas most likely to be sensitive to acidic deposition has been completed. In the northeast, the highest percentage of lakes with pH <5.0 occurs in the Adirondacks (10 percent of number of lakes, 1.6 percent of lake area). The Western Lake Survey found only one acidic lake fed by an acidic hot spring.

The Alk/Ca + Mg ratio will decrease from a value near unity for a lake unaffected by atmospheric deposition to zero or less as the waters are acidified. Analysis of surface water chemistry from about 8500 lakes in eastern Canada shows ratios varying from less than zero to 1.0 in lakes from western Ontario eastward and south of 52° latitude. This deficit results from the presence of sulfates. Several studies in Canada and in the U.S. have shown that natural organic acids cannot account for the acidic status of these lakes.

Over the past 50-60 years, no significant change in alkalinity in tested lakes in New Hampshire (an area of relatively high acidic deposition) is apparent and average pH may have increased. During this period, the pH and alkalinity of Wisconsin (an area of relatively low acidic deposition) lakes have increased significantly. In the Adirondacks (an area of relatively high acidic deposition) pH and alkalinity have remained constant or decreased.

Water chemistry in the Sudbury area has shown major decreases in sulphate concentrations and substantial increases in pH and alkalinity since the early 1970's when large local $SO_2$ emission reduction programs were implemented.

In concert with these emission reductions, historical data at Joe Lake near Sudbury spans a complete cycle of fish extinction from acidification in the 1950's to nearly full recovery by 1984 following stocking in 1977. This demonstrates recovery potential for even highly acidified lakes.

An experiment in Norway has shown rapid response (1 year) of a very sensitive acidified watershed when deposition is reduced.

Recent measurements of shallow groundwater (less than one metre) have shown acidification by mineral acids.

7. Crops - Dose/response experiments in laboratory and field grain crops show no significant reduction in yield over a wide variety of species when exposed to simulated acidic deposition in the ambient range experienced in eastern North America.

In contrast, for an average 7 hr growing season concentration of ozone of about 90 ug/m$^3$ (45 ppb) over the eastern U.S. and southeastern Canada, all species tested including major grains and vegetables show a reduction in yield over controls which were exposed at 40-50 ug/m$^3$, (20-25 ppb).

8. Forests - Results of a controlled study on seedlings of tulip poplar, white oak, and virginia pine using simulated acid rain over three growing seasons at pH 5.7, 4.5, 4.0, and 3.5 showed no significant response in growth, photosynthesis or morphological properties.

Another study exposed eleven species of deciduous and coniferous seedlings during their first five weeks from germination to simulated rain at pH 5.6, 4.6, 3.6, and 2.6. (Author's Interpretation: Treatment with pH $<$ 4.6 rain was sufficient to induce statistically significant growth reduction and morphological changes in coniferous seedlings). (U.S. Interpretation: Except at pH of 2.6 there were no significant effects on cumulative germination, survival or above ground biomass. Effects on some morphological characteristics were ambiguous at pH 3.6 and 4.6).

Seedlings of four tree species (hybrid poplar, sugar maple, northern red oak, and eastern white pine) common in northeastern U.S. were exposed to a range of ozone levels up to 280 ug/m$^3$ over the growing season. This resulted (Figure 22) in reductions in net photosynthesis of 10 to 40 percent over growth under an assumed background level of about 50 ug/m$^3$.

Surveys of red spruce in New England and New York have shown some retardation in growth in the low elevation forests and serious decline and visible damage on spruce trees above cloud base. There is a major sugar maple dieback in Quebec and to a lesser extent in Ontario. Surveys have been carried out in Quebec and it is noted that "there were very few cases of maple stands totally exempt of damage in some form or another". Some damage was observed in 40% of the 533,582 hectares surveyed. The Quebec surveys indicate that dieback of sugar maple occurs throughout its range and within different forest types and on several different sites. Surveys of beech, red maple and yellow birch in New Brunswick and parts of Nova Scotia bordering the Bay of Fundy have shown decline symptoms. Soutnern pine in the southeastern piedmont region have shown reduced growth in recent decades. Natural stresses and air pollution have been proposed as causative factors for all three observations, and experiments have been planned to test these hypotheses. At present, these survey observations cannot demonstrate whether or not acidic deposition is a factor.

9. Materials - While exposure to the atmosphere clearly causes corrosion of various materials, and acids should accelerate the process, these relationships have not been quantified.

Long-term exposures of galvanized steel specimens show runoff losses of zinc that are dependent on total acid deposition

Senator **Ford**. I do not believe I have any further questions. That statement supports your position well, and it has been your position for a long time. If you will just stay with it long enough, everything will work out all right.

Have you celebrated your anniversary yet?

Mr. **Bagge**. No. I will be one year old on June 16th.

Senator **Ford**. Is it June 16th?

Mr. **Bagge**. June 16th. That is when I had my heart attack, last June 16th.

Senator **Ford**. Yes, I know.

Mr. **Bagge**. That's when I died and I was reborn, Senator.

Senator **Ford**. He is an interesting fellow.

Mr. **Bagge**. So are you, Senator.

Senator **Ford**. You have been at it longer than I have. But I look forward to celebrating your anniversary.

Mr. **Bagge**. Thank you, sir.

Senator **Ford**. Mr. Webb, I am personally pleased and I think the Committee is pleased that GRI is participating in furthering the clean coal program, both with EPA and as a project sponsor in DOE's first clean coal technology—clean coal solicitation. Is that not correct?

Mr. **Webb**. Yes, sir.

Senator **Ford**. Okay. We understand that gas-enhanced emission control has been called a near term technology. Can you comment on what you mean by "near term" and will this technology be ready for commercial use tomorrow?

Mr. **Webb**. Yes, sir. First, let me answer the last one first. No, it will not be ready for commercial use tomorrow. By near term, we think that, assuming that the DOE contract is signed in the next two or three months, and we anticipate that it would be, that we would have demonstrated in commercial utility boilers by the 1990, 1991 time frame this technology, will have built a data book of the actual results and costs, will have tested several different coals, and will have documented results, and will be working with boiler manufacturers and utility host sites, that then the technology could in fact be applied starting in the '91-'92 time frame.

But that would mean widespread use of the technology still would be 1995 or later, Senator.

Senator **Ford**. Near term is seven years away, eight years away?

Mr. **Webb**. Yes. I guess I mean near term from the standpoint that we should be able to demonstrate it within the next three or four years. There's still the whole prudency issue that Mr. Bagge brought up and there's still the problem of, once it's demonstrated and you've documented the results, there's a tremendous amount of infrastructure out there, that this takes a long time to retrofit these power plants.

I don't think there are any near term technologies that can be installed tomorrow in any of these emerging clean coal technologies, sir.

Senator **Ford**. There are a lot of people who want action now, and I think those who are familiar with the industry, that have studied the industry, indicate: one, that if we go and we do have action now and we go to scrubbers, the long term costs are going to be horrendous.

It will not be good economics if we go to scrubbers. Not only will it create other environmental problems, but also it will stretch out the lifetime of a utility, coal-burning utility.

Two, it reduces the efficiency almost immediately and the cost is accelerated.

So we have to push clean coal rather fast, as I see it. How fast should we go? We talk about spending money, but I'm a little bit concerned about the first up front $500 million, as you heard me earlier. I think there might be a little smoke and mirrors with that $500 million.

But how fast should we really go?

Mr. WEBB. Senator, based on our experience, I think you should push as hard as you can for the next two or three years to get anywhere from another billion to $1.5 billion of these demonstrations out there.

And with the industry having to put up 50 percent, most people will do like we are. They will go to a host utility and get that utility involved, get those demonstrations out there. And like you say, some of them will work and some of them will not work.

But get them out there so that in the early nineties there's a lot of these plants out there operating, where regulators, manufacturers, executives of the utilities can visit the sites, look at the data, look at the operational problems, and make their own choices.

So I think the need is to go ahead and demonstrate these. There's probably a need for what Senator Byrd has proposed to demonstrate, what he calls the commercial ones. But I think that you're going to have to demonstrate these right now first, and then that's in the 1990's, when you're talking about taking and making them commercial.

Senator FORD. Well, in that vein a little bit, Mr. Webb, this Senator is concerned and I think many members of the Committee are concerned about the proper timing of a deployment program that they keep referring to. How can Congress better coordinate the timing of a demonstration program with the timing of a deployment program, so that we get the most benefits from these technologies?

Mr. WEBB. Senator, by deployment program you mean when they would be commercially deployed?

Senator FORD. Yes, sir.

Mr. WEBB. Well, it would seem to me that if you insist that they demonstrate a wide range of technologies and demonstrate them in the different types of boilers that are out there in the utility sector, and you don't pass some kind of acid rain legislation that mandates the technology or mandates a time schedule such that you can't use these technologies, I don't think you have to worry about the deployment if Senator Byrd's bill takes care of, if you would, the prudency factor and the fact that you can roll it into the rate base.

Then the utilities will select the one that's best for their particular site, the type of coal that they're using, the type of equipment and stuff they're planning to install.

I think the deployment will take care of itself once you get these things demonstrated and you get some of the regulations squared away.

Senator **Ford**. Mr. Webb, let me ask you this question. Will utilities in your view utilize clean coal technologies on a commercial basis without regulatory changes?

Mr. **Webb**. Senator, I really don't know. I think it'll come down to economics. Those technologies that offer them greater efficiency and a way to reduce the overall costs or to use local coals which are cheaper because of transportation will be implemented.

Some of these technologies, if you didn't have any requirements at all regarding acid rain controls, I don't think would be implemented, because obviously it's cheaper just to burn coal without having to go through some of these cleanup processes.

Senator **Ford**. Well, do you believe that the current state and federal regulatory climate inhibits the deployment of clean coal technologies?

Mr. **Webb**. Yes, sir, I do, primarily because there's a tremendous—it's not just the electric utilities. The pipelines, which I'm more familiar with, gas pipelines, there's a tremendous amount of second guessing in this country now of whether an investment made five years or ten years ago in accordance with then regulations which have since changed is prudent.

You know, you're seeing—as Mr. Bagge said, they're not building new power plants today because, number one, they're worried about being allowed to recover the cost of the capital in their rate base and in their rates, because they're afraid that somebody will take them to court and claim that it wasn't a prudent investment and therefore you should disallow the costs and the shareholders should have to eat that cost.

Until that regulatory climate changes, then it's going to be very hard to deploy these technologies, even if they're demonstrated successfully in the clean coal program.

Senator **Ford**. Did I understand you in your earlier comment that if stringent acid rain legislation was passed, that that would probably inhibit the process we are going through now as it relates to clean coal technologies?

Mr. **Webb**. Yes, sir, unless you set the timetables far enough out and unless you build flexibility into tradeoffs between different types of pollutant reductions, so that a utility executive truly has a wide menu of options that he can select from to meet the law and still provide the most cost effective solution.

Senator **Ford**. To get to your tradeoffs again, explain to me what would be a legitimate tradeoff in your definition of tradeoffs?

Mr. **Webb**. What I'm getting back to is we know how to reduce $NO_x$ by using this reburn country the Japanese developed and are using, and we're bringing it over here and testing. I mean, that has been documented on commercial scale in foreign countries and that can be done, and it's relatively cost effective.

The tradeoffs, I think—I believe it's Senator Kerry of Massachusetts, his bill proposes that the states be allowed to substitute NOx reductions for $SO_2$ on a ratio of two to one. In other words, if you had a standard that said you had to reduce $SO_2$ by 90 percent, but the utility man would say: Okay, I choose to reduce $NO_x$ 50 percent; that means then that I would only have to reduce my $SO_2$ 65 percent.

Probably he can do that more cost effectively than a total 90 percent on $SO_2$ without any requirement whatsoever on $NO_x$. And they both contribute—we don't know to what extent, and as Mr. Bagge said, we're not sure it's as great a problem as some people would try to lead you to believe.

The two to one ratio, I'm not sure. You probably ought to get some people up here that are actually scientists in the acid rain precursor technologies, sir. That was his suggestion. It seems reasonable.

Senator FORD. I do not have any other questions for either gentlemen. If you have any kind of closing remarks you want to make that we have talked about——

Mr. WEBB. Senator Ford, I would just like to make a closing remark, to thank you. Most people do not think about gas when they think about clean coal technologies, and of course I think we do have a future in that. And I would urge you and the Committee to really press on DOE to get on with the clean coal demonstration program, because I think ultimately it is essential for us to be able to use our domestic resources instead of being captive to ever-rising levels of imported oil, sir.

Senator FORD. I appreciate your comments, Mr. Webb. I have never been one that has said that there is not a place for all sources of energy. We all have a place in this economy, and we also have a very vital stake in the future and our security.

So I just do not want one excluded. I think they all ought to be included, and that is one reason you are here. And we are going to do everything we can to bring everybody in to try to find some answers.

Now, the record will be left open until April the 22nd, and any further comments or anything that you would like to make, we would be happy to have you do that. We are looking forward to Secretary Wampler's answers in writing to my earlier questions.

I thank both of you gentlemen for being here today and look forward to working with both of you to expedite what I think all of us agree is the proper direction to go.

This hearing is adjourned.

[Whereupon, at 10:50 a.m., the hearing was adjourned.]

# APPENDIXES

## APPENDIX I

## RESPONSES TO ADDITIONAL COMMITTEE QUESTIONS FROM APRIL 2, 1987, HEARING

FOLLOW-UP QUESTIONS FROM SENATOR FORD
HEARING ON CLEAN COAL TECHNOLOGIES
APRIL 2, 1987

Questions for EPRI, EEI and Clean Coal Technology Coalition Witnesses

1. Please comment on how the current state and federal regulatory climate impedes the development and deployment of clean coal technologies. How would federal regulatory changes facilitate the commercialization of these technologies?

2. Would utilities use clean coal technologies on a commercial basis without regulatory changes?

3. Does Senator Byrd's bill, S. 879, adequately address the regulatory problems of deploying clean coal technologies? What other incentives do you believe to be necessary to carry these technologies to commercialization?

4. Please enumerate on the environmental and economic benefits to the U.S. from:

(a) encouraging the development and ultimate deployment of clean coal technologies, rather than the immediate enactment of emissions control legislation?

(b) using the emerging clean coal technologies, rather than using conventional scrubbers?

5. Do you believe that a federal deployment program will assure that utilities and others will undertake the projects necessary to demonstrate the commercial feasibility of emerging clean coal technologies?

6. Senator Byrd's bill proposes a $3.5 billion program to be administered over ten years, while the Administration's recent proposal is for a five-year, $2.5 billion program. Please comment on the appropriate timing for a "deployment" program, especially given the various stages of maturity of clean coal technologies.

FOLLOW-UP QUESTIONS FROM SENATOR DOMENICI
APRIL 22, 1987 HEARING - CLEAN COAL TECHNOLOGY

(Questions for all witnesses)

1. Please comment on the maturity of the various clean coal technologies, especially with respect to the proper timing of a "deployment" program. How can we better coordinate the demonstration phase with the deployment phase, so that we reap the most benefit from these technologies?

2. Some people have proposed that the government's contributions to the cost-shared clean coal projects be offered as grants with no repayment requirements. Yet, from a purely fiscal standpoint, it seems to make good sense to require at least some partial repayment to the Treasury for those projects that realize a profit to the private entity who benefited from the joint venture. What is your opinion on this?

3. How well does Senator Byrd's bill, S. 879, address the regulatory problems of deploying clean coal technologies? What other regulatory changes/incentives do you feel are needed to encourage private investment in clean coal technologies?

4. If an advisory panel were established to coordinate and make recommendations on clean coal technology development, what sectors should be represented on this panel?

EPRI
Electric Power
Research Institute

May 12, 1987

Ms. Cheryl Moss
Senate Energy & National Resources Committee
SHOB 312
Washington, DC 20510

Dear Ms. Moss:

I have attached my responses to the questions asked by Senators Ford and Domenici following the April 2 hearings on clean coal technology conducted by the Subcommittee on Energy Research and Development. These responses are intended to supplement my testimony given at the hearing.

Thank you again for the opportunity to offer counsel to the Subcommittee and its staff. I look forward to hearing from you if I can be of further assistance.

Very truly yours,

Richard E. Balzhiser
Executive Vice President

REB:vbe

Attachment

3412 Hillview Avenue, Post Office Box 10412, Palo Alto, CA 94303 Telephone (415) 855-2000
*Washington Office: 1800 Massachusetts Ave., NW, Suite 700, Washington, DC 20036 (202) 872-9222*

## FOLLOW-UP QUESTIONS FROM SENATOR FORD
## HEARING ON CLEAN COAL TECHNOLOGIES
## APRIL 2, 1987

Question #1: Please comment on how the current state and federal regulatory climate impedes the development and deployment of clean coal technologies. How would federal regulatory changes facilitate the commercialization of these technologies?

Response: There are several facets of the current regulatory climate which impede clean coal technology development and deployment. These include the following:

**DOE Procurement Regulations.** These regulations, and their interpretation, provide powerful disincentives to cooperative R&D intended to expedite the availability of clean coal technology. Examples include proposal requirements concerning precise prediction of the environmental or commercial potential of developmental technologies, ambiguity concerning the terms and conditions of federal assistance repayment, and restrictive public ownership requirements for proprietary technology.

**Environmental Regulatory Uncertainty.** The continuing threat of administrative "racheting" of regulations as a result of the technology-forcing aspects of the Clean Air Act tends to retard both the development and deployment of more effective technology. There is little incentive to invest in "better mousetraps" by either developer, supplier, or user unless assurance is provided that a new technology can be nurtured without either regulatory violation or being rendered suddenly obsolete by administrative presumption of technical performance.

**Cost Recovery and Presumption of Prudence:** Regulated utilities are discouraged from sharing in the risks associated with development and deployment of Clean Coal Technology because of the threat that the investment will not be recovered through the rate setting process. It is therefore particularly important that both federal and state governments make a joint commitment to foster clean coal technology as an investment for the common good and to assure that the using public as well as the stockholder share both risk and reward.

Question #2: Would utilities use clean coal technologies on a commercial basis without regulatory changes?

**Response:** In my judgment, the technologies being developed under the DOE clean coal technology program for new and repowered plant applications will ultimately be commercialized because of their inherent cost advantages combined with emission control capabilities. We see this today for atmospheric fluidized bed combustion (AFBC) where commercial utility and cogeneration commitments are proceeding. The pace of deployment for AFBC and other new and repowering clean coal technologies will, however, be slowed substantially by the regulatory impediments outlined under Question #1.

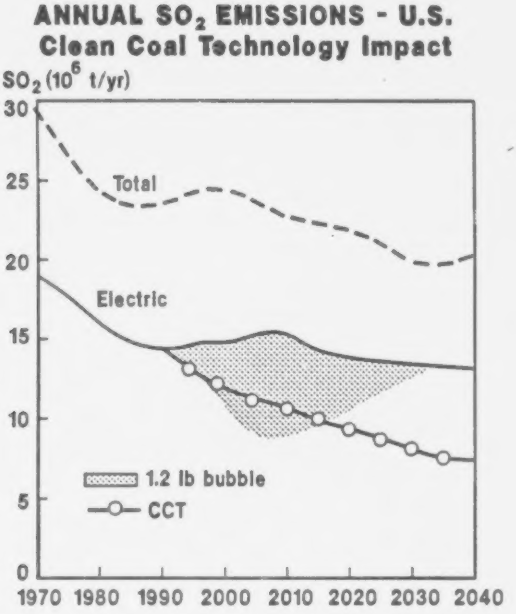
Question #3: Does Senator Byrd's bill S. 879, adequately address the regulatory problems of deploying clean coal technologies? What other incentives do you believe to be necessary to carry these technologies to commercialization?

Response: Senator Byrd's bill, S879, does address key regulatory problems which pace deployment of clean coal technology. The specific issues of cost recovery and presumption of prudence under the Federal Power Act are addressed particularly well. Most electric utility generating capacity is, however, under state, not federal regulation. While this bill recognizes this fact and proposes federal coordination with the states it is unclear how successful this coordination will be in extending cost recovery and presumption of prudence to the state level. Until this fundamental federal/state policy issue is uniformly resolved, clean coal technology deployment will be slowed.

Question #4: Please enumerate the environmental and economic benefits to the U.S. of clean coal technology.

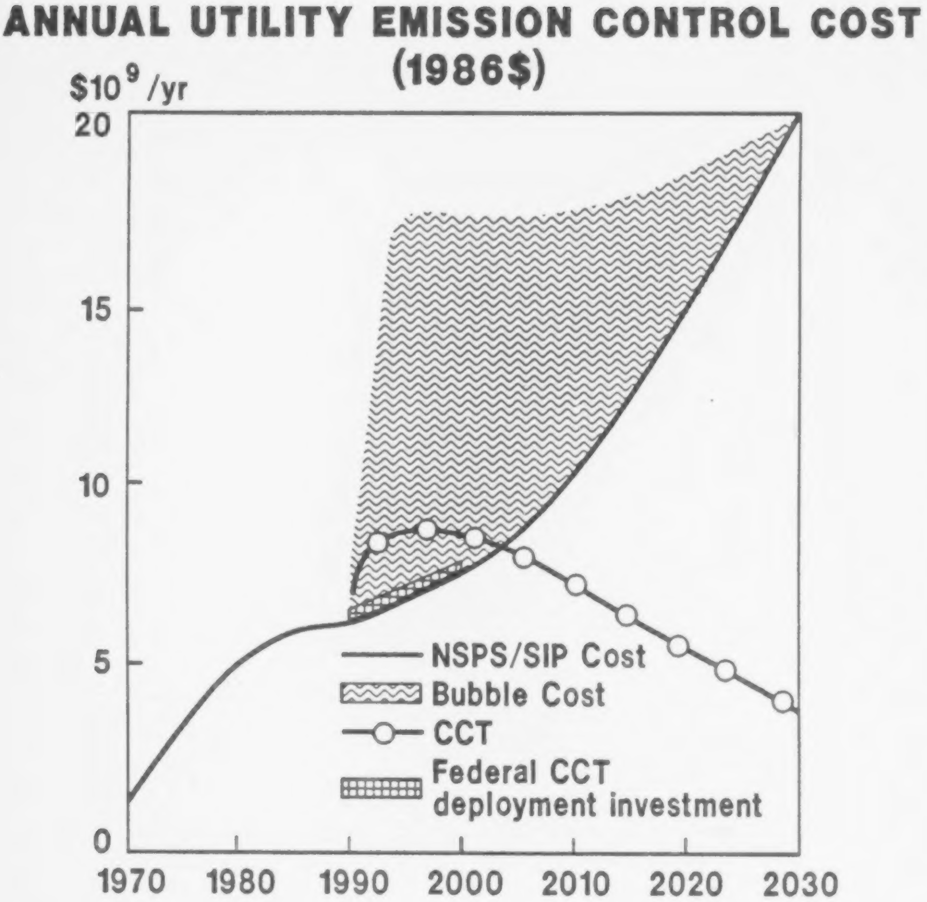
Response: The environmental and economic benefits to the U.S. of clean coal technology deployment versus the immediate enactment of emission control legislation are summarized in the attached Figures 4-1 and 4-2. In Figure 4-1, for example, the area bounded by the solid curve and the dotted curve labelled CCT Plants, represents the probable $SO_2$ control impact of promptly deploying clean coal technology. It represents the inherently greater $SO_2$ control efficiency of these technologies relative to current NSPS. This scenario can achieve and, most importantly, sustain a level of emission reduction exceeding that of the typical retrofit emission control legislation now being proposed. Just as the utility industry now controls emissions substantially beyond State Implementation Plan (SIP) requirements, so it is likely that the clean coal technology path for new and repowered plants will be followed on economic and productivity grounds. This path will, however, be delayed unless the current regulatory disincentives to new technology application are eliminated and an orderly, risk-shared, deployment program is initiated. An additional delaying factor would be the diversion of resources to an extensive emission control retrofit effort.

FIGURE 4-1



- Total: Total U.S. emissions trend
- Electric: Electric power emissions based on 2.3% per year demand growth, 60 year fossil plant life and no change in fuel sulfur content or control requirements (Baseline).
- New CCT Plants: Emission trend resulting from utilization of advanced clean coal technology. The rate of market penetration is strongly influenced by deployment incentives.
- Bubble: Emission trend resulting from a state-wide emission control bubble of 1.2 lb $SO_2$/MBtu.

FIGURE 4-2



ANNUAL UTILITY EMISSION CONTROL COST (1986$)

The impact of a retrofit 1.2 lb/MBtu $SO_2$ state-wide emission bubble is also indicated by the cross-hatched area. This provides only a marginally larger $SO_2$ reduction peak which rapidly diminishes and converges with the New CCT Plant scenario by 2015. Environmental science indicates that any emission control strategy which does not sustain its reduction well beyond that achievable through this retrofit approach is unlikely to demonstrate any real improvement in the environmental issues for which it is intended.

The comparative cost implications of these scenarios is described in Figure 4-2. The annual net cost savings associated with the CCT deployment scenario, relative to continuing current power plant design practice, grows continuously. These savings result from the ability to integrate and simplify emission control, reduce construction time, build modular power plants better matching load growth, and increase fuel flexibility-thus reducing the major operating cost element in power generation.

On the other hand, the additional cash flow requirements associated with legislatively imposed retrofit emission control scenarios relying on conventional scrubbers and coal switching rapidly rise to a peak of about $10 billion/year in additional control costs. Such restrictive emission control legislation and its diversion of resources would act as a powerful deterent to the commercial deployment of emerging clean coal technology.

In this context, the history of conventional flue gas desulfurization (FGD) scrubbing technology in the United States provides a valuable but very expensive lesson on the price of exchanging "technology forcing" legislation and regulation for a cooperative development and deployment effort.

Contrary to sound development practice, FGD scrubber technology bypassed the scale-up process and was prematurely deployed at commercial scale as a result of legislative and regulatory "technology forcing" requirements. The deployment process occurred in an adversarial atmosphere where the incentive was on least first-cost without adequate understanding of, or insurance against, the performance and reliability risks involved. As a result, this "brute force" approach to development and deployment has involved 60,000 MW of electric generating capacity to date at a total cost to the utility industry and rate payer of over $20 billion (1987 $) in capital, operating and lost generating capacity costs during the past 15 years. Only now is the technology approaching acceptable reliability, although at an excessive cost in operational risk protection and redundancy which still requires substantial development attention.

Had FGD scrubber technology been developed and deployed in a more rational and cooperative manner, the cost could have been reduced to $1-2 billion involving no more than 2000 MW of capacity. In addition, the legacy of poor performing or obsolete commercial scrubber installations and the resulting ill-will on the part of the user could have been avoided. One need look no further than the Japanese experience with FGD scrubbing technology to see the contrasting success and cost effectiveness of the more rational, cooperative approach to risk shared development and deployment.

**Question #5**: Do you believe that a federal deployment program will assure that utilities and others will undertake the projects necessary to demonstrate the commercial feasibility of emerging clean coal technologies?

**Response**: The effectiveness of a federal deployment program will be directly proportional to the success that program has in removing the various federal and state regulatory disincentives discussed earlier, and to the policies ultimately selected to guide both technology demonstration and deployment. Based on the limited experience of DOE's Phase I Clean Coal Technology Demonstration Initiative, the following observations are offered:

a. There is an ample array of private sector projects identified to achieve demonstration and commercial deployment of the full range of clean coal technologies now under development.

b. Several factors are likely to determine the success of the program:

   - The federal philosophy of project selection should better reflect its role as an expeditor, not the purchaser, of technology to be commercially utilized by the private sector. In this regard an industry task force should be established which is authorized to provide combined business and technical guidance for project selection and to advise on federal procurement procedures which inhibit technology.

   - The selection criteria should better reflect the potential environmental and commercial importance of each technology. Cost and risk sharing should be applied more flexibly to ensure that the denied range of clean coal technology is adequately demonstrated and deployed.

- Ambiguity concerning repayment of federal assistance should be eliminated. This is particularly important to encourage stronger participation by the nation's largest user of coal, the electric utility industry.
- Eliminate federal and state regulatory barriers to cost recovery by electric utilities and to presumption of prudence for clean coal technology demonstration and deployment projects.
- Avoid premature and restrictive emission control legislation and regulations which would delay, and direct resources away from, clean coal technology deployment to ineffective "band-aid" retrofit programs effectively limited to scrubbing is coal switching.

Question 6: Senator Byrd's bill proposes a $3.5 billion program to be administered over ten years, while the Administration's recent proposal is for a five-year, $2.5 billion program. Please comment on the appropriate timing for a "deployment" program, especially given the various stages of maturity of clean coal technologies.

Response: Three primary factors determine the timing for a "deployment" program intended to achieve commercial maturity for the technologies involved.

a. The range of clean coal technologies involved

b. The schedule for completion of prototype demonstration

c. The scope of deployment (number of units and subsidized operating period).

The following summarizes our logic in addressing these questions. First, we have identified nine generic categories of innovative Clean Coal Technology involving at least 64 deployment projects to achieve maturity over the range of design and operating conditions required by the utility industry. If we assume no further delays in the implementation of Phase I and Phase II of the federal Clean Coal Technology Demonstration Initiative, and couple that with the on-going, privately financed demonstrations, all nine generic clean coal technologies could complete prototype demonstration by the early 1990s.

Construction and five years of subsidized operation for this array of deployment projects would probably involve at least seven to ten years, following completion of prototype demonstration. The less complex technologies such as dry sorbent injection and combustion $NO_x$ control would typically be completed first with advanced FGD, PFBC and IGCC, for example, following. In conclusion, a 10 year time period for cost shared "deployment" is more realistic recognizing that risk costs are involved in operating as well as capital investment.

# FOLLOW-UP QUESTIONS FROM SENATOR DOMENICI
# HEARING ON CLEAN COAL TECHNOLOGIES
## APRIL 2, 1987

Question #1: Please comment on the maturity of the various clean coal technologies, especially with respect to the proper timing of a "deployment" program. How can we better coordinate the demonstration phase with the deployment phase, so that we reap the most benefit from these technologies?

Response: As indicated in the Question 6 response for Senator Ford, the various candidate clean coal technologies should complete prototype demonstration by the early 1990s. Based on the results of those demonstrations, the market place can then judge both the benefits and remaining risks associated with commercial deployment. Several technologies, such as dry sorbent injection and atmospheric fluidized bed combustion, are well advanced in demonstration with deployment opportunities already defined. Given the lead time on planning and implementing commercial deployment projects, it is therefore important that the deployment initiative proceed immediately in coordination with the completion of these demonstrations.

Rather than a fixed level of government risk sharing, it would seem most cost-effective to invite the private sector to competitively bid for deployment projects and risk sharing. This would let the market place, based on demonstration results, define both the specific technologies to deploy and the risk sharing necessary for each to achieve deployment. The much larger number of potential utility host sites relative to deployment project requirements, for example, would assure a truly competitive environment.

Question #2: Some people have proposed that the government's contributions to the cost-shared clean coal projects be offered as grants with no repayment requirements. Yet, from a purely fiscal standpoint, it seems to make good sense to require at least some partial repayment to the Treasury for those projects that realize a profit to the private entity who benefited from the joint venture. What is your opinion on this?

Response: The extent of federal cost sharing and repayment should be tailored to the specific needs of each technology. In each case the objective should be to assure their expedited development and confident commercial application. For example, clean coal technology for new and repowered plants have substantial economic and environmental benefit potential relative to current technology. Here market incentives may reduce the degree of risk sharing necessary to achieve prompt commercial deployment. It is also these technologies which I believe provide the greater benefit by resolving the conflict between emission control and productivity.

On the other hand, retrofit emission control technologies, which are primarily cost control insurance for potential control legislation affecting existing plants, may require a higher percentage of federal cost-sharing to provide the incentive necessary for demonstration and deployment by the private sector. These are less effective in strategically controlling emissions than the technologies directed to new or repowering applications and do not improve productivity.

If the clean coal technology involves a definite proprietary product which produces a profit then it may be appropriate for the government to share in that profit commensurate with its risk share. This recovery may, however, be illusory since the government's profit share may actually be added to the sales price of the technology.

It is important to note, however, that many clean coal technologies, particularly for retrofit emission control, represent individualized equipment modifications to the power plants of regulated utilities. In this case there may be no specific proprietary product which can be marketed and reproduced at a profit. Here, the host utility not only lacks opportunity to achieve a rate of return but may not even be able to recover the cost of its investment. Under such circumstances the requirement that government recover its cofunding is a powerful disincentive to utility participation. This fact is reflected for example, by the relative lack of retrofittable utility emission control technology projects in Phase I of the DOE Clean Coal Technology Demonstration Initiative.

Cofunding is only one element of government assistance however. It should also encourage programs designed to increase private sector R&D efforts and reduce the need for direct government involvement. For example, the state of Ohio has recently taken the initiative of funding clean coal technology demonstration programs in such a way that the industrial partners retain the commercial and managerial incentives. The state role is to promote demonstrations by sharing part of the cost and insuring a reasonable rate of return on the remainder by acceptance in the utility rate base. Taken a step further, federal encouragement of favorable state action becomes even more important to the prompt commercial deployment of clean coal technology by the regulated electric utility industry. Particularly important are expedited permitting reviews, presumption of prudence, and prompt cost recovery.

Question #3: How well does Senator Byrd's bill, S. 879, address the regulatory problems of deploying clean coal technologies? What other regulatory changes/incentives do you feel are needed to encourage private investment in clean coal technologies?

Response: Please refer to the Question 3 response for Senator Ford.

Question #4: If an advisory panel were established to coordinate and make recommendations on clean coal technology development, what sectors should be represented on this panel?

Response: Such a panel is strongly encouraged and could provide valuable input for the prioritization and selection of clean coal technology based on productivity and environmental potential. The most important technology advisory element should be the private sector users, primarily the electric utility industry, who are ultimately responsible for demonstration and deployment, as well as commercial application. They and their research and development arms should be joined by representatives from the technology manufacturers, architect/engineers, and the environmental community including EPA. To be workable, such a panel should be restricted to no more than 20 members who collectively are expert in the full range of candidate technologies .

Close liaison should also be maintained between this technology advisory panel and the equally important federal/state government coordinating mechanism designed to achieve the necessary clean coal technology cost and risk sharing incentives. If these functions operate in isolation from one another, there is considerable risk that the incentives and the technology selection may be inconsistent leading to further delay and waste of resources.

May 7, 1987

Responses to questions of the Senate Energy and Natural Resources Committee submitted by A. Joseph Dowd on behalf of the Clean Coal Technology Coalition

Follow-up Questions From Senator Ford:

1. Please comment on how the current state and federal regulatory climate impedes the development and deployment of clean coal technologies. How would federal regulatory changes facilitate the commercialization of these technologies?

RESPONSE:

There is a high degree of risk in today's regulatory climate that a retrospective prudency review will be conducted and expenditures already made will be found to have been imprudent. Given the intensity of the regulatory controversies which have developed over the last several years resulting from these restrospective reviews and concerning capital expenditures for new capacity, many utilities have adopted strategic plans which call not only for the least possible capital expenditure, but also for the making of only those capital expenditures that are unquestionably required to satisfy customer service duties. Clean coal technology investments are particularly exposed in this regulatory climate because it is likely that initial investments in clean coal projects will be discretionary expenditures. Thus, the very high technical risks associated with use of a new technology, when coupled with regulatory uncertainty, so concerns the electric utility industry as to deter much investment in new technologies.

The uncertainty associated with changes to environmental regulations also deters development and deployment of these technologies. If, for example, proposed legislation or regulatory changes which impose additional controls upon emissions were adopted, utilities would not have the financial resources also to pursue new technology development. Even the prospect of stricter standards impedes pursuit of these technologies.

Federal regulatory changes that are designed to create more certainty that investments once made can be recovered if projects are prudently pursued would be a powerful stimulus toward assuring accelerated development and deployment of clean coal technologies. Those regulatory incentives set forth in S. 879 are the type of provisions that would facilitate widespread use of clean coal technologies.

2. Would utilities use clean coal technologies on a commercial basis without regulatory changes?

RESPONSE:

Clean coal technologies probably would eventually be commercialized without regulatory changes, but a "business-as-usual" commercialization process is likely to result in the passage of many years before utilities will utilize new clean coal technologies on a widespread basis. Without incentives, it is likely that a pioneering utility will first attempt the demonstration of a given technology and that same utility will then construct the first commercial-scale project. If successful, another utility may then incorporate the technology into its system, and so on until the technology is widely accepted by the utility industry and its regulatory agencies.

Given the current disincentives inherent in rate regulation as presently applied to new, expensive technologies, and the uncertainties associated with environmental regulation, utilities will choose to apply new clean coal technologies sparingly and then only when the technical risks have been minimized by vendor guarantees and utility commissions are convinced that ratepayers are not exposed to undue risks. Of course, to achieve this level of comfort will take an inordinate amount of time or, alternatively, will require assistance in minimizing the risks involved. A properly designed federal program could greatly accelerate commercialization.

3. Does Senator Byrd's bill, S. 879, adequately address the regulatory problems of deploying clean coal technologies? What other incentives do you believe to be necessary to carry these technologies to commercialization?

RESPONSE:

S. 879 adequately addresses the rate regulatory impediments to the deployment of clean coal technologies.

The financial incentives also provided under S. 879 for selected projects are very important in assuring that industry will proceed quickly to the construction of a multiple number of commercial-sized clean coal projects.

Also, certainty with respect to the maintenance of current environmental regulations would provide a strong impetus toward development and deployment of clean coal technologies. The mere threat of changes in environmental regulation tends to stymie utility commitments to new technologies. Rather than use capital to develop or construct new clean coal technology projects, utilities will likely preserve those funds to comply with any new environmental regulations. Importantly, compliance with new regulations would be accomplished by use of existing technologies (e.g. the current generation of scrubbers).

Finally, because approximately 80 percent of utility revenues are subject to regulation at the state rather than the federal level, incentives provided by the states are vitally important. In this regard, it would be exceedingly helpful if the states were to adopt regulatory incentives similar to those prescribed under S. 879 for implementation at the federal level.

4. Please enumerate on the environmental and economic benefits to the U.S. from:

(a) encouraging the development and ultimate deployment of clean coal technologies, rather than the immediate enactment of emissions control legislation?

(b) using the emerging clean coal technologies, rather than using conventional scrubbers?

RESPONSE:

The immediate enactment of emissions control legislation will significantly delay and may preclude totally the development of clean coal technologies. This is so because compliance with the requirements of emissions control legislation similar to that pending in the Senate Committee on Environment and Public Works will be achieved by electric utilities through fuel switching, with its associated social and economic disruption or the use of present day costly sludge generating scrubbers. The very significant expenditures required to comply with proposed emissions control proposals -- estimated to cost as much as $12 billion per year over the remaining life of affected powerplants -- will simply drain the financial resources of those utilities most interested in clean coal technology development.

If clean coal technologies are not allowed to advance because utility resources are diverted to emission control requirements, then future electric demand, which is estimated to exceed current and planned capacity additions by the mid-1990's, will be met using existing pulverized coal technology and current generation scrubbers. The present commercial coal-fired technology is near the end of its development potential. New power generation options must meet increasingly stringent siting and environmental demands while maintaining productivity and at the same time be susceptible to construction in modules over a range of unit sizes so as better to match capacity additions to demand. It is increasingly difficult for utilities to cost-effectively use conventional coal-fired generation capacity to meet these requirements. The consequence of failing to develop new technologies is that ratepayers may very well pay excessive amounts for electricity and utimately the nation will pay in economic competitiveness. The Electric Power Research Institute has testified before the Senate Energy and Natural Resources Committee that clean coal technologies now under development could reduce the cost for necessary capacity additions by more than 50% relative to current experience.

In addition, emerging clean coal technologies will meet environmental requirements more cost-effectively relative to current generation scrubbers. Also, some promising technologies are projected to exceed the emissions reductions now obtained by current generation scrubbers. Thus use of new clean coal technologies will better assure that there will be a sustained reduction in emissions of both sulfur dioxide and nitrogen oxides even though coal utilization is expected to increase dramatically in the next century.

Use of emerging clean coal technologies rather than conventional scrubbers was best described in a recent DOE publication entitled America's Clean Coal Commitment, February 1987. A copy of a chart comparing the costs and the benefits of clean coal technologies to conventional scrubbers is attached to this response. Scrubbers are costly and, in some cases, generate a wet sludge which creates costly waste disposal and environmental problems. Further, scrubbers control emissions of sulfur dioxide only; several new clean coal technologies control not only sulfur dioxide but nitrogen oxide emissions as well.

5. Do you believe that a federal deployment program will assure that utilities and others will undertake the projects necessary to demonstrate the commercial feasibility of emerging clean coal technologies?

RESPONSE:

YES. An adequately funded financial assistance program along with favorable regulatory incentives implemented at the federal and state level will not only provide the best assurance that clean coal projects will be undertaken, but that they will be commercialized sooner than would otherwise be the case. Utilities, and other interested parties, have already demonstrated an interest in the development of these new technologies as evidenced by the substantial response (139 responses) to DOE's solicitation earlier this year for statements of interest to retrofit, repower or modernize existing powerplants with new clean coal technologies.

6. Senator Byrd's bill proposed a $3.5 billion program to be administered over ten years, while the Administration's recent proposal is for a five-year, $2.5 billion program. Please comment on the appropriate timing for a "deployment" program, especially given the various stages of maturity of clean coal technologies.

RESPONSE:

Unlike the proposal envisioned by the Administration request, S. 879 would allow financial incentives for other than electric utility projects. Thus, other industries that use coal would be eligible for the proposed financial assistance program.

Also, it should be noted that expending up to $5.0 billion over a five year period (50-50 cost-sharing between government and industry) in a truly effective manner may not be feasible given other constraints upon the electric utility industry and upon those support services and personnel needed to design and construct these clean coal technology projects (e.g. can sufficient steel be produced?; are there sufficient numbers of craftsmen and skilled laborers available to be dedicated to a series of major construction projects?). Further, some technologies, including the pressurized fluidized bed combustion technology, may simply not be ready for commercialization within the next five years. Thus, in terms of the amount of funding and the period of time for implementation of the deployment program, S. 879 is probably more realistic.

Follow-Up Questions From Senator Domenici:

1. Please comment on the maturity of the various clean coal technologies, especially with respect to the proper timing of a "deployment" program. How can we better coordinate the demonstration phase with the deployment phase, so that we reap the most benefit from these technologies?

RESPONSE:

The majority of clean coal technologies are projected to have completed the demonstration stage by no later than the mid-1990's. While there are differences of opinion as to exact dates, the Department of Energy's recently published study entitled America's Clean Coal Commitment includes information relevant to this question. That information is attached for the Committee's information and use.

The private sector likely will be required to contribute at least fifty percent of the cost of a clean coal technology project under a deployment program. With this type of financial commitment the private sector is in a position to judge the maturity of a technology and presumably will propose only those technologies that are ready for commercialization. Thus, the marketplace should be afforded the opportunity to designate which technologies are ready for the "deployment" program. This can be accomplished by leaving to the marketplace the ability to choose projects. Under this approach it is important that sufficient time be made available so that technologies not yet fully demonstrated are afforded the time required to complete the demonstration stage before commercial-sized projects are undertaken.

Several years may be needed in order to plan for and design a commercial-sized clean coal technology project. This being the case, a deployment program should not be postponed until more technologies have been demonstrated. By enacting the deployment program now, industry will have an opportunity to plan projects, to apply for financial assistance through the deployment initiative, and to acquaint regulators with the technologies so that favorable treatment is forthcoming when the projects are actually undertaken. In other words, it is none too soon to initiate the deployment phase.

2. Some people have proposed that the government's contributions to the cost-shared clean coal projects be offered as grants with no repayment requirements. Yet, from a purely fiscal standpoint, it seems to make good sense to require at least some partial repayment to the Treasury for those projects that realize a profit to the private entity who benefitted from the joint venture. What is your opinion on this?

RESPONSE:

While cost-sharing is appropriate, repayment is not. A repayment requirement is very likely to decrease the level of participation in the program. It should be noted that even if a project is successful, the rates which a regulated utility is allowed to charge are governed on a cost of service basis. For a utility to repay the federal contribution, rates permitted by a utility commission would have to be in excess of the amount required to repay the utility for its incurred costs plus a reasonable return on its investment. Why should that utility's ratepayers be required to repay the federal contribution for a technology that will be available not only to that utility but to all utilities and ratepayers in the country as well? It should be understood that reduction in costs stemming from technology improvements benefit the ratepayers rather than the shareowners/investors. Further, if the technology development involves risk, there is usually no provision for additional benefit to the investors who supply the capital for the risk-bearing installation. And, in fact, should the installation be less than successful, retroactive prudency proceedings which are currently in vogue suggest that risk would be born by the same investor who is unrewarded for having taken the risk. This situation calls to mind the phrase "tails you win, heads I lose."

In the case of retrofit installations, there is no new utility revenue stream to be derived from any clean coal technology installation. Thus, there could be no repayment from additional revenues. In the case of repowering or new capacity, the only revenues that might be available would be those incremental revenues which result from lesser capital costs or greater efficiencies achieved over the next most economical and efficient alternative. These incremental revenues are small or non-existent, particularly in the case of immature technologies which may be more expensive in the near term than the mature versions of those technologies. While these realities exist, a requirement for repayment would simply serve to dampen the enthusiasm for participation in the program. Care should be taken so that this lessening of participation does not occur.

The ability to repay is probably no better for manufacturers of clean coal technologies. The vendor that submits to a utility bid which contains no research and development component costs is likely to be chosen over one that developed the technology and must roll that development cost into his bid. If repayment of the federal portion of a project is required, then the vendor that conducted no research or development can simply obtain the information about the technology from the public record and bid lower than the vendor that must include in his estimate the cost of repayment. That would be a particularly unfortuate outcome. Utility commissions in viewing a company's purchasing practices generally do not make provision for a vendor's research and development expenses. Least-cost is the rule.

3. How well does Senator Byrd's bill, S. 879, address the regulatory problems of deploying clean coal technologies? What other regulatory changes/incentives do you feel are needed to encourage private investment in clean coal technologies?

RESPONSE:

The principal regulatory problems revolve around uncertainty that a utility will be permitted to recover the costs expended and obtain a return upon those costs. S. 879 addresses the principal regulatory problems associated with the deployment of clean coal technologies. Additional regulatory changes/incentives needed to encourage private investment in clean coal technologies involve, most importantly, the adoption by the states of the regulatory incentives contained in S. 879. Also, uncertainties associated with changes to enviromental regulations are very significant. Even the possibility of imposition of further emissions controls is a strong deterrent toward making any commitments that will require substantial funding. Protection of these clean coal technology investments against more stringent future environmental regulations, through the establishment of a "safe harbor", should be given serious consideration.

4. If an advisory panel were established to coordinate and make recommendations on clean coal technology development, what sectors should be represented on this panel?

RESPONSE:

Representation on an advisory panel would, of course, depend upon the purpose of such a panel. If the panel is to assist the DOE in choosing technologies and/or projects to be supported, then a panel of experts knowledgeable with respect to the technologies would be most appropriate. Such a panel should include a strong representation from industry. If the purpose of such a panel is to assist in determining market acceptance of technologies, then representatives from various state regulatory agencies would be appropriate as well as representatives from the user industries.

Penelec GPU
Pennsylvania Electric Company
1001 Broad Street
Johnstown, Pennsylvania 15907
814 533-8400

R. L. Wise
President

May 13, 1987

The Honorable Wendell H. Ford
Chairman
Subcommittee on Energy Research & Development
Senate Committee on Energy & Natural Resources
312 Hart Senate Office Building
Washington, D.C. 20510

Dear Chairman Ford:

I appreciate the opportunity to have testified before your Subcommittee Hearing on April 2, 1987, regarding clean coal technologies.

As requested, enclosed are responses to the questions submitted by you to EPRI, EEI and the clean coal technology witnesses, and also by Senator Domenici to all of the witnesses. I hope the responses sufficiently provide you and the other subcommittee members with the information needed.

Again, thank you for allowing me the opportunity to have testified. Should you have any further questions, or concerns about the responses, please don't hesitate to contact me.

Sincerely,

Robert L. Wise

Enclosures

# FOLLOW-UP QUESTIONS FROM SENATOR FORD
# HEARING ON CLEAN COAL TECHNOLOGIES
# APRIL 2, 1987

Questions for EPRI, EEI and Clean Coal Technology Coalition Witnesses

## QUESTION 1

Please comment on how the current state and federal regulatory climate impedes the development and deployment of clean coal technologies. How would federal regulatory changes facilitate the commercialization of these technologies?

## RESPONSE

The uncertainties and costs of new technology development and use, which pose significant risks for any industry, are particularly difficult in and at times incompatible with the regulatory environment in which electric utilities operate.

There is a strong inclination on the part of utilities and the commissions which regulate them for the industry to confine themselves to proven technologies when significant levels of investment are required. In this risk averse climate, a utility could face a substantial or even total disallowance of its costs if an untried technology does not meet expectations. Also, the potential that currently exists for retrospective prudency review means that utilities can be second guessed by their utility commissions long after substantial commitments and expenditures have been made. Even if the technology proves to be successful, the amount and timing of any return on what is a risky and substantial investment will be uncertain, depending upon whether, when, and to what extent public utility commissions treat these expenditures in establishing base revenues.

Federal regulatory changes that would create more certainty that reasonable investment costs could be recovered would facilitate the commercialization of these technologies and could serve as a model for state regulatory commissions that share the federal government's interest in accelerating technology development.

## QUESTION 2

Would utilities use clean coal technologies on a commercial basis without regulatory changes?

## RESPONSE

The utility industry has been, and continues to be, an enthusiastic participant and financial supporter of the development of new clean coal technologies, and significant progress is being made toward bringing these technologies to the commercial marketplace. However, given the barriers to new technology development in a mature, capital intensive, and regulated industry, improved generation technology is not likely to become fully commercial in a short time period unless the risks are minimized and shared. The current clean coal demonstration program, and deployment initiatives such as those on Senator Byrd's bill, should accelerate the acceptance of new technologies by utilities and their regulatory commissions as alternatives to already proven, though costly and less efficient, conventional technology.

QUESTION 3

Does Senator Byrd's bill, S. 879, adequately address the regulatory problems of deploying clean coal technologies? What other incentives do you believe to be necessary to carry these technologies to commercialization?

RESPONSE

The regulatory provisions in S.879 outline significant incentives to help overcome the obstacles to new technology development and use that are unique to the regulated utility industry. They would provide an important degree of certainty that reasonable investment costs could be recovered. This certainty does not currently exist with regard to investment in new and unproven technologies.

Since it is the states that have much of the regulatory authority which will affect the future success of the clean coal program, their cooperation and participation needed. S.879 encourages the states to adopt the same regulatory incentives provided at the federal level.

QUESTION 4

Please enumerate on the environmental and economic benefits to the U.S. from:

(a) encouraging the development and ultimate deployment of clean coal technologies, rather than the immediate enactment of emissions control legislation?

(b) using the emerging clean coal technologies, rather than using conventional scrubbers?

RESPONSE

Enactment by Congress of costly new emission control legislation at this time clearly is unwarranted because; (1) substantial progress on emission controls has already been, and will continue to be, achieved under the present Clean Air Act; (2) the growing body of scientific data indicates that acid rain is not the environmental threat originally feared; (3) the costs of new acid rain legislation would be considerable with uncertain environmental benefits; (4) the adverse job and international trade competitiveness effects of acid rain legislation are certain and substantial; and (5) the developing clean coal technologies have great promise for deployment over the next decade. Prudent judgment should prompt Congress to await, at a minimum, the completion of the NAPAP study, due in late 1989, and further demonstration of clean coal technologies before it considers any additional emission control legislation.

There are several advantages to using emerging clean coal technologies as opposed to conventional scrubbers:

1) They offer potential for much more cost-effective control of sulfur dioxide emissions;

2) Most offer the added advantage of nitrogen oxide control;

3) They avoid or reduce the sludge problems associated with scrubbers. In some cases, they even produce marketable by-products;

4) They are expected to generate more power with less fuel, and with reduced maintenance and operation costs.

5) Many can be constructed rapidly in increments thus better matching capacity to actual demand. This too should help to both increase the reliability of electricity supply and reduce consumer costs.

Requiring the immediate enactment of emissions control legislation, however, likely would lock the utility industry into using conventional scrubber technology as few, if any, utilities would risk the possibility of non-compliance through reliance on an unproven technology. This could preclude the development of these promising new technologies.

## QUESTION 5

Do you believe that a federal deployment program will assure that utilities and others will undertake the projects necessary to demonstrate the commercial feasibility of emerging clean coal technologies?

## RESPONSE

Utilities and other interested parties already have demon strated a strong interest in the development of these technologies. When the Department of Energy solicited a first round of proposals for the program in late 1984, the private sector responded with 176 submissions involving 159 specific projects from sponsors in 29 states. The most recent solicitation for statements of interest, targetted specifically to retrofitting, repowering or modernizing existing facilities, drew 139 proposals.

While statements of interest do not represent actual proposals, they do indicate the type and scope of projects that could be candidates for later competitive procurements.

An adequately funded financial assistance program, together with the types of regulatory changes under consideration, should accelerate the development of a wide array of new clean coal technology options.

QUESTION 6

Senator Byrd's bill proposes a $3.5 billion program to be administered over ten years, while the Administration's recent proposal is for a five-year, $2.5 billion program. Please comment on the appropriate timing for a "deployment" program, especially given the various stages of maturity of clean coal technologies.

As the question recognizes, the different clean coal technologies are at varying stages of development. While some are expected to have completed the demonstration phase by the mid-1990s, other promising technologies may not be available for commercialization until later. Consequently, a longer program should allow the development of a wider range of technologies.

In addition, a longer deployment program would allow industry to learn from the earlier demonstrations and incorporate changes into subsequent projects. This broadened experience base should help to reduce operation and maintenance costs and improve reliability.

## FOLLOW-UP QUESTIONS FROM SENATOR DOMENICI
## APRIL 2, 1987 HEARING - CLEAN COAL TECHNOLOGY

(Questions for all witnesses)

QUESTION 1

Please comment on the maturity of the various clean coal technologies, especially with respect to the proper timing of a "deployment" program. How can we better coordinate the demonstration phase with the deployment phase, so that we reap the most benefit from these technologies?

RESPONSE

While the exact dates for commercial availability of various technologies are speculative, information on this is included both in the testimony of the Electric Power Research Institute and in the Department of Energy's recent study entitled America's Clean Coal Commitment. From these and other sources, it appears that different technologies are at different levels of maturity and consequently, are likely to require differing incentives and timeframes for development. Some technologies may be far enough along in the demonstration process to require relatively little in terms of incentives and time in order to move to deployment. Others, however, may not be ready for deployment for a number of years.

In any case, however, it likely will take several years to plan and design a commercial-sized clean coal technology project. Knowing what types of assistance may be available should facilitate and accelerate that planning process, and in turn accelerate deployment.

QUESTION 2

Some people have proposed that the government's contributions to the cost-shared clean coal projects be offered as grants with no repayment requirements. Yet, from a purely fiscal standpoint, it seems to make good sense to require at least some partial repayment to the Treasury for those projects that realize a profit to the private entity who benefited from the joint venture. What is your opinion on this?

RESPONSE

As I mentioned in my testimony, we are concerned about the requirement of the current clean coal program that the private sector not only share at least fifty percent of the costs of a demonstration project, but also repay the government's cost-share contribution. Under this DOE repayment requirement, a utility which has subjected its ratepayers to risk for the utility share of a demonstration project is being asked to repay the government if the project succeeds. Clearly, the utility's ratepayers will benefit if the project is successful. However, so will other ratepayers in other utility systems that ultimately deploy these demonstrated technologies. We believe the government's portion for the project should be viewed as that portion of risk-sharing which the government bears on behalf of all ratepayers and taxpayers. The government's contribution should be viewed as a sound leveraged investment, serving as a catalyst to provide incentives stimulating the development and demonstration of technologies beneficial to the entire country.

We strongly urge that such a repayment requirement not be part of any future DOE solicitations. If it is, the incentive for private industry participation will be severely diminished and could adversely affect industry's response.

QUESTION 3

How well does Senator Byrd's bill, S. 879, address the regulatory problems of deploying clean coal technologies? What other regulatory changes/incentives do you feel are needed to encourage private investment in clean coal technologies?

RESPONSE

The regulatory provisions in S.879 provide significant incentives to help overcome the obstacles to new technology development and use that are unique to the regulated utility industry. They would provide an important degree of certainty that reasonable investment costs could be recovered. This certainty does not currently exist with regard to investment in new and unproven technologies.

QUESTION 4

If an advisory panel were established to coordinate and make recommendations on clean coal technology development, what sectors should be represented on this panel?

RESPONSE

The producer and user industries, with expertise in the potential and constraints of the technologies should be well represented, as should the major coal producing and consuming states. Representatives from the technology manufacturers could provide valuable technical expertise. Representatives from various federal and state regulatory agencies could provide valuable input regarding the market acceptance of the technologies. In addition, because of the potential for more cost effective power generation, it may be appropriate for electricity consumers to be represented. Similarly, because of the potential of these technologies for emissions reductions, the environmental community should be represented.

# APPENDIX II

## RESPONSES TO ADDITIONAL COMMITTEE QUESTIONS FROM APRIL 9, 1987, HEARING

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**Department of Energy**
Washington, DC 20585

May 28, 1987

Honorable Wendell H. Ford
United States Senate
Washington, D.C. 20510

Dear Mr. Ford:

On April 9, 1987, J. Allen Wampler, Assistant Secretary for Fossil Energy appeared before the Subcommittee on Energy Research and Development of the Committee on Energy and Natural Resources to discuss the Department's budget request for clean coal technology programs.

Following the hearing, you submitted written questions for our response to supplement the record. Enclosed are the answers to those questions, which also have been sent directly to the Committee staff.

If you have any questions, please have your staff call Roger Sindelar or Tom Todd on 586-4277. They will be happy to assist you.

Sincerely,

G. Thomas

Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosures

# ANSWERS TO POST-HEARING QUESTIONS FROM THE MINORITY
RELATING TO THE
APRIL 9, 1987, HEARING
BEFORE THE
SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
WITNESS: J. ALLEN WAMPLER
ASSISTANT SECRETARY FOR FOSSIL ENERGY
U.S. DEPARTMENT OF ENERGY

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 1: As part of Phase I of the DOE Clean Coal Technology Program, on July 25, 1986, the Department announced the selection of nine clean coal technology proposals for negotiation (List 1.1). In addition, DOE identified 14 other proposals which constitute a second list (List 1.2) from which additional proposals may be selected if funding is available.

a. What is the current status of Phase I of the Clean Coal Technology Program?

b. What is the status of the negotiations on the nine selected proposals on List 1.1? What is the schedule for completion of such negotiations?

c. How much of the $400 million appropriated for Phase I is expected to be obligated for the proposals on List 1.1?

d. Does the Administration anticipate undertaking negotiations on any of the proposals on List 1.2? If so, when?

e. Which of the proposals on List 1.1 would be eligible for assistance under Phase II? Which have submitted proposals in response to the Phase II solicitation?

f. Has construction begun on any of the nine projects on List 1.1?

g. What are completion dates for such projects?

Answer a: Phase I of the Clean Coal Technology program has a number of activities in progress. The Cooperative Agreements for two projects have been fully executed by both the industrial participant and the DOE. Phase I activities (i.e., design) are underway in both the Tidd PFBC Demonstration Project as proposed by the American Electric Power Service Corporation and the Advanced Cyclone Combustor with Integral Sulfur, Nitrogen and Ash Control Project proposed by Coal Tech Corporation. The Cooperative Agreement for a third project, the LIMB Demonstration Project Extension has been signed by the industrial participant, the Babcock and Wilcox Company and the

Comprehensive Report has been submitted to Congress for review. The Cooperative Agreement for a fourth project (i.e., Gas Reburning and Sorbent Injection) has been signed by the industrial participant, Energy and Environmental Research Corporation and the Comprehensive Report to Congress for this project is being prepared. With respect to the other five projects, work is focused on the preparation of the pre-negotiation documents. In addition to these efforts on the projects themselves, effective project management teams established at the Pittsburgh and Morgantown Energy Technology Centers are performing a wide range of activities which extend from project cost estimates to preparation of NEPA documentation. The program has in place the mechanisms to effectively complete the negotiations, implement the projects and bring these projects of the CCT program to a successful conclusion.

b. The status of the nine projects included as Phase I is:

- The projects proposed by the American Electric Power Service Company on behalf of the Ohio Edison and by Coal Tech Corporation are underway. Cooperative agreements with each of these companies have been signed.

- The Babcock & Wilcox Company has signed the cooperative agreement for the LIMB project extension and the Comprehensive Report has been sent to Congress for review.

- The Energy and Environmental Research Corporation signed a cooperative agreement on May 15, 1987, for the Sorbent Injection/Gas Reburning Project.

- The project proposed by General Electric is in final review prior to the start of active negotiations.

- Pre-negotiation plans have been or are being prepared for the projects proposed by:

  Weirton Steel Corporation
  M. W. Kellogg Company
  Energy International Inc.
  Ohio Ontario Clean Fuels Inc.

It is expected that negotiations on all of these projects will be completed by the end of June 1987.

c. The present schedule calls for $366 million to be obligated on the proposals for List 1.1. This does not include $25 million set aside as a management reserve or related Program Direction amounts.

d. There are currently twelve proposed projects on List 1.2 since the propsals submitted by Wisconsin Electric Power Company and McDonnell Douglas Energy Systems, Inc. have been withdrawn. Only if the negotiations with a potential participant now on List 1.1 cannot be completed for whatever reasons, would we then initiate the selection of a replacement project from the list of alternatives.

e. To ensure that the broadest range of technologies is demonstrated under the CCT Programs, projects that duplicate any of the nine selected projects that are presently undergoing negotiations for award of cooperative agreements will not likely be considered for award under the second round of solicitations. This policy is consistent with the guidance received from Congress in the "Joint Explanatory Statement of the Committee of Conference for the FY 1987 Continuing Appropriations" which stated that "...It is not the managers' intent to consider projects which duplicate previous demonstration." However, we do not want to preclude consideration of alternative approaches, new generations or improved versions of a general category of technology. It should be noted, however, that the potential industrial participants with projects now on List 1.2 can submit proposals for consideration under Phase II of the Program. Many of these industrial participants responded to the recent Informational Solicitation issued by the Department.

f. Construction has begun on some of the major pieces of equipment to be used in the PFBC project being managed by the American Electric Power Service Company (e.g., the pressure vessel for the fluidized bed) and in the advanced combustor project proposed by the Coal Tech Corporation (e.g., the burner).

g. The estimated completion date for the "Tidd PFBC Demonstration Project" proposed by the American Electric Power Service Corporation on behalf of the Ohio Power Company is April 1993. The project entitled "Advanced Cyclone Combustor with Integrated Sulfur, Nitrogen and Ash Control" proposed by the Coal Tech Corporation is scheduled to be completed by February 1989. The estimated completion date for the "Limestone Injection Multistage Burner (LIMB) Demonstration Project Extension" proposed by the Babcock & Wilcox Company is December 1990. It is too early to forecast accurately completion dates for the remaining six projects which are in negotiations. However, they are all expected to be completed by the early- to mid-1990's.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 2: One of the criteria for selection of proposals is that the projects selected must increase the use of coal "in an environmentally acceptable manner."

a. In making its selection of proposals for negotiation under Phase I, in what specific way did the DOE formally consult with the Environmental Protection Agency, or other federal or state environmental agencies?

b. For the projects on Lists 1.1 and 1.2, provide for the record the DOE environmental evaluation of each proposal.

Answer a: DOE follows a formal procedure in making selections for large programs. The decisions (selections) are made by a Source Selection Official. As input to that decision, he receives a report from the Source Evaluation Board (SEB). The SEB is responsible for evaluating each qualifying proposal against each of the criteria. In evaluating the proposals against the environmental criteria, DOE sought, and received, input from EPA for the SEB. An EPA representative was an advisor to the SEB. He provided comments on each proposal which was considered by the SEB in conducting their evaluation. EPA also had a representative on the flue gas cleanup Technical Evaluation Committee, whose comments were utilized by that committee for input to the SEB.

b. The evaluation of the environmental data submitted for each proposal is part of the data compiled by the Source Evaluation Board, as it prepared recommendations for the Source Selection Official. These evaluations contain considerable amounts of business and project proprietary data protected. Because the negotiations on the selected proposals are not complete, this information regarding our evaluation of the environmental data is very sensitive and may be exempt from public disclosure. Such a disclosure could adversely affect the continuing negotiations. Therefore, we request that the submission of the evaluation results pursuant to your request be deferred until the negotiations have been completed with all proposers selected under Phase I of the Clean Coal Technology Program.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 3: On November 12, the DOE published a notice of solicitation for statements of interest in, and informal proposals for, projects that retrofit, repower, or modernize existing facilities.

a. How does the scope of the Phase II solicitation differ from that of Phase I?

b. When does DOE intend to select Phase II proposals for negotiation?

Answer a: First, the November 12 notice requested informational proposals, so that DOE could report to Congress on the potential interest in and ideas for projects to retrofit and repower existing facilities. The informational solicitation was more limited in scope than the first Clean Coal Technology Program (CCT-1), since it was linked to technologies capable of retrofitting and repowering existing facilities. Phase II (now part of the Innovative Control Technology Demonstration Program) was proposed as part of the President's FY 1988 budget request.

b. DOE plans to select projects, subject to Congressionally proposed program approval and appropriation in the spring of 1988.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 4: The Department's January 1987 budget request for Fiscal Year 1988 proposes an increase in funding for the Clean Coal Program of $350 million over the next five years to conduct a Phase II and III. The Department's April 4, 1987, budget amendment requests $500 million per year in Fiscal Years 1988 through 1992 for the Acid Rain Innovative Control Technology Demonstration Program.

a. What is the difference between the types and sizes of projects that would be conducted under Phase II and Phase III of the Clean Coal Technology Program?

b. Why did the Administration in its January submission to the Congress propose delaying funding for Phase III of the Clean Coal Technology Program until 1990?

c. What is the difference between the types and sizes of projects that would be conducted under the Clean Coal Technology Program and the Acid Rain Innovative Control Technology Demonstration Program?

Answer a: As noted in the Department's Amendment to the FY 1988 budget request, the next phase of the Clean Coal Technology Program will implement the President's Innovative Clean Coal Technology Program. This Program will focus on retrofit and repowering projects that are more responsive to the criteria and recommendations of the Special Envoy's (Lewis-Davis) Report on Acid Rain. While the type of projects will be determined by this technology focus, it is expected that the size of these projects will be similar (i.e., demonstration/precommercial) to those proposed in the first phase.

b. In the FY 1988 budget request, as originally submitted, the Administration proposed additional funding in FY 1990 to accomodate the continued development of promising innovative concepts now in the final stages of the research and development effort. While it is too early to consider these concepts for a demonstration project now, they could be very viable candidates within the 1990 time frame.

c. The scope of the Innovative Clean Coal Technology Program (ICCT) is narrower than the scope of the initial Clean Coal Program (CCT-1). ICCT is applicable to technologies that can be used to retrofit and repower existing coal fired facilities and that can control emissions of $SO_2$ and $NO_x$. It is anticipated that the size of the projects conducted under the Clean Coal Technology Program and the Innovative Control Technology Demonstration Program will be about the same. The type of projects will be determined by the criteria established in the solicitation. These criteria will reflect the Department's emphasis on retrofit and repowering technologies, as well as its desire to be responsive to the recommendations of the Special Envoy's Report.

QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

CLEAN COAL TECHNOLOGY PROGRAM

Question 5: Does the President's March 18 pronouncement --

a. Preclude conducting Phase II of the DOE Clean Coal Technology Program?

b. Preclude conducting Phase III of the DOE Clean Coal Technology Program?

c. Alter the direction or scope of the DOE Clean Coal Technology Program to focus it on fulfilling the criteria set forth in the Special Envoy's Report on Acid Rain?

Answers a&b: The President's announcement of an expanded Clean Coal Initiative on March 18, 1987, incorporated many of the concepts included in the proposed Phase II and Phase III of the Clean Coal Technology Program. However, the level of funding and the timing of the solicitations proposed are different. The President's Initiative is to seek advanced funding in the amount of $500 million a year for five years, commencing with FY 1988. The funding would be used to structure multiple rounds of competition. The competitive procurements would be sequenced in such a way as to encourage new, potentially improved clean coal concepts to continue their development progress. For FY 1988, it has been proposed that the $500 million request be made up of $350 million to be drawn from the remaining funds in the Clean Coal Technology Reserve Fund and $150 million that the Congress had previously appropriated and scheduled to become available in fiscal 1988 for the first round of CCT projects.

c: The President's Initiative does launch an aggressive program leading to the clean use of coal. This commitment also represents the full amount of the Government's share of the funding recommended by the Special Envoys' on Acid Rain. As such, the criteria set forth in that Report will be utilized to the fullest extent practicable for the new program. These criteria are, however, the same as was previously considered for Phases II and III, proposed earlier for the CCTP.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 6: What are the environmental and economic benefits to be obtained from the use of clean coal technologies compared to conventional methods of pollution control, such as scrubbers?

Answer: Conventional coal cleaning has only a limited ability to remove sulfur impurities, typically only 10% to 30% of the total sulfur of coal. Flue gas scrubbing is very costly and can be applied only to plants that have the available space required. To operate, scrubbers must consume a portion of the power plant's energy, thereby lowering efficiency, and today's typical systems produce massive amounts of a pasty waste product that is difficult to handle. Coal switching is also very costly not only in terms of the premium that must be paid to purchase and transport lower sulfur coal from mine to user but also in the social disruptions that would result from major shifts in supply sources.

The limitations of conventional controls are compounded by the wide diversity of the Nation's utility boiler population in terms of boiler designs, ages, sizes, etc., as well as the type of coal consumed. Each of these factors can limit the effectiveness in applying any of the three conventional emission control options--coal cleaning, flue gas scrubbing, or coal switching.

If further emission reductions are to be achieved without incurring great costs or dislocations, innovative technologies will be needed that are less sensitive to fuel type and that can retain acceptable economics over a wide range of boiler sizes and types.

Many of these new technologies also offer the advantage of significant $NO_x$ control, something that the conventional $SO_2$ control options can't achieve. And all produce an easily disposed of or, in some cases, a useable waste product.

Innovative clean coal technologies can generally be grouped into two categories: (1) retrofit technologies which can be used on existing plants to reduce emissions, and (2) repowering technologies that replace a significant portion of the original plant and often increase capacity while reducing emissions.

These emerging technologies offer significant improvements in cost-effective environmental performance, compared to previous alternatives. For example, advanced physical coal cleaning can potentially reduce $SO_2$ emissions by 65%, more than double the effectiveness of conventional techniques, and chemical and microbial cleaning may boost that effectiveness to 90% or more.

Retrofit techniques such as the limestone injection multistage burner, slagging combustors, gas reburning, induct sorbent injection, and advanced flue gas cleanup, used separately or in combinations, can control both $SO_2$ and $NO_x$ and produce an environmentally safe waste product. Although the sulfur emission reduction potentials of some of these technologies are lower than conventional flue gas scrubbing, the reduction levels will likely be sufficient to meet possible future requirements for existing plants.

Repowering technologies, such as integrated gasification combined cycle (IGCC) and fluidized bed combustion (FBC) are able to reduce both $SO_2$ and $NO_x$ emissions. In the case of IGCC, sulfur emission reductions greater than 99% have been achieved, while pressurized FBC is capable of lowering sulfur emissions by 95%. IGCC technologies can also reduce $NO_x$ emissions by 40% compared to conventional coal-fired power plants, while pressurized FBC technologies can achieve a $NO_x$ reduction of up to 85%.

In addition to improved environmental performance, the new clean coal technologies, particularly repowering concepts, also offer substantial technical and economic benefits. Repowering an existing power station with IGCC for example, can improve its efficiency from a nominal 35% to as much as 40% and increase its power output by up to 150%. This boost in power production offsets most of the capital costs of refurbishing an aging plant, thereby resulting in only a minimal impact on the cost of electricity.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 7: When do you expect that clean coal technologies under development privately or with DOE support will be commercially available (performance contracts can be signed) or ready for replication,

a. Generally?

b. The specific technologies under Phase I negotiations?

c. The technologies anticipated from Phase II negotiations?

Answer a: Generally speaking, it is anticipated that these technologies will be commercially available for replication in time to provide real solutions to problems projected to occur in the utility industry in the mid-1990's. At that time many utilities will require these innovative clean coal technologies to decide how best to meet the conflicting demands created by aging facilities, increasing demand, environmental responsibilities, etc.

b. The specific technologies being demonstrated under Phase I of the Clean Coal Technology Program have development programs ranging from three to five years. These programs are to provide all the data needed to replicate these concepts on a commercial scale. Accordingly, these particular concepts will be available for commercial use in the period around 1990-1992.

c. The innovative control technologies that would be selected in the proposed second solicitation of the Clean Coal Program will be available for commercial application only shortly after those demonstrated in the first phase. It is expected that these technologies also will be available as options to the industrial and utility sectors to consider as solutions to their various problems by the mid-1990's.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 8: When do you anticipate that utilities will be prepared to sign contracts for clean coal technologies.

a. Generally?

b. The specific technologies under Phase I negotiations?

c. The technologies anticipated from Phase II negotiations?

Answer a: The utility industry is composed of a large number of plants located on sites that vary widely in their specific characteristics. These factors, coupled with the individual local, state, and federal regulations that may apply, requires the utility industry to make decisions almost on a site-by-site basis. The consideration of general trends would indicate that utilities will be looking for some clean coal options (retrofit, repowering, facility modernization) by the mid- to late-1990's; however, some are having to make these decisions now or will have to do so in the near future.

b. Considering the length of the lead time associated with the design, construction, and startup of either a new facility or a significant addition, some utilities are currently evaluating the technologies being demonstrated in Phase I as near-term options. These planning efforts anticipate the availability of key data from the demonstration projects for final design activities. It is believed that some contracts may have already been signed that would make available the technologies for use in design studies leading to its full application when demonstrated.

c. It is expected that the utilities will follow closely the demonstration of any technology that has the potential to become an option suitable for solving their particular problem(s). As soon as this technology has advanced to the stage that it can provide realistic data for for planning purposes, it is anticipated that the utility will make conditional commitment to have the ability to begin preliminary design. In the case of those technologies to be demonstrated as a result of the second solicitation, these contracts should be signed somewhere in the early 1990's.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 9: The President announced that he was establishing an Innovative Control Technology Advisory Panel.

a. What is the anticipated membership of the Panel?

b. What are the anticipated functions of the Panel?

c. Will the Panel have a role in, or be responsible for, designing the Federal program?

d. Will the Panel have a role in, or be responsible for, evaluating specific proposals?

Answer a: It is anticipated that the Panel will be comprised of:

- Chairman - DOE Under Secretary
- 2 additional members from DOE
- 2 members from EPA
- 1 member each from OMB and Departments of Commerce, Interior, and State
- 2 members from the Canadian Government
- Private sector and citizen's groups
- Several state government officials

b. The anticipated functions include:

- Advise and recommend to DOE activities related to development of innovative technologies to control emissions.
- Review programs to determine if they are likely to provide poential added control options.

- o Review, evaluate, and advise on proposed project selection criteria for cost shared projects.

- o Develop information to fill gaps in technology development programs to be used in future solicitations.

c. The panel will have a role in the Federal program by way of advise and recommendations to the Secretary of Energy on evaluation criteria, scope of projects, and other factors related to the program.

d. No, the proposal evaluation process is protected to isolate it from political or other outside biasing influences and is separated from the panel concerning specific proposals.

## QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

## CLEAN COAL TECHNOLOGY PROGRAM

Question 10: What are the special commitments of the Canadians, compared to the United States, regarding --

a. funding a clean coal technology demonstration program?

b. control of atmospheric emissions that contribute to acid rain?

Answers a&b: This information had also been requested by Chairman John Dingell, of the House Committee on Energy and Commerce, to be submitted by the Departments of Energy and State and the Environmental Protection Agency. The necessary data is being collected, and a joint response from all three agencies will be prepared for transmittal to Mr. Dingell in the near future. A copy of this joint response will be forwarded to the Senate Committee on Energy and Natural Resources at that time.

QUESTIONS SUBMITTED BY REPUBLICAN MEMBERS

CLEAN COAL TECHNOLOGY PROGRAM

Question 11: S. 879 addresses Federal and State regulatory issues affecting the deployment of clean coal technologies.

a. Do you agree that the issues addressed are problem areas and do you agree with the proposed legislative solution? If not, what legislative solution would you propose as an alternative?

b. What other regulatory issues or changes do you feel are needed to encourage deployment of clean coal technologies?

Answer a: The President's Task Force on Regulatory Relief has embarked on a study of Federal and State economic and regulatory programs to examine incentives and disincentives to deployment of clean coal technologies. The findings and results of the Task Force review will be reported in 6 months along with any recommendations for change to existing regulations.

We believe that the regulatory provisions of S. 879 should be carefully reviewed by the Task Force; some of them may be capable of implementation without the need for further legislation.

b. The Task Force is looking at the full slate of Federal, state, and local regulations that may encourage or impede the deployment of CCT's. Their report will be completed by the end of September of this year.

# APPENDIX III

## ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

### STATEMENT
### OF
### SOUTHERN CALIFORNIA EDISON COMPANY
### REGARDING
### COAL GASIFICATION TECHNOLOGY AND
### THE EXPERIENCE GAINED WITH ITS APPLICATION
### AT THE
### COOL WATER INTEGRATED COAL GASIFICATION COMBINED CYCLE PLANT

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HEARINGS OF
THE ENERGY RESEARCH AND DEVELOPMENT SUBCOMMITTEE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

APRIL 2 and APRIL 9, 1987
WASHINGTON, D.C.

Dr. Lawrence T. Papay, Senior Vice President
Southern California Edison Company
P.O. Box 800
Rosemead, CA  91770

Program History

Southern California Edison Company (Edison*) and Texaco, Inc. (Texaco) began preliminary discussions in 1977 about the possibility of utilizing gasification technology which Texaco developed over the last 30 years in an integrated gasification combined cycle (IGCC) process for the commercial production of electricity. As a result of these discussions, an agreement was reached in July 1979 to pursue the Cool Water Coal Gasification Program (Program). Since then, the agreement has been amended to expand the Program participation to other companies while soliciting additional technical expertise and capital contributions.

The Electric Power Research Institute (EPRI), Bechtel Power Corporation (Bechtel), and General Electric (GE), joined the Program in 1980. The Japan Cool Water Program Partnership (JCWP) joined the Program in 1982 (JCWP is a consortium of interested Japanese industrial organizations headed by Tokyo Electric Power Company). Two nonequity Contributors, the Empire State Electric Energy Research Corporation (ESEERCO) and SOHIO Alternate Energy Development Company (SOHIO) joined the Program in 1982 and 1984, respectively, at a lower level of funding to obtain limited technical information. All capital costs were funded by private industry.

* Southern California Edison Company is an investor-owned electric utility serving approximately 10 million people over a 50,000 square mile area of Southern California.

See the table below for Capital Funding.

Program Capital Funding
(Millions of Dollars)

| Participants | | Committed Funds |
|---|---|---|
| Edison | | 25 |
| Texaco | | 45 |
| EPRI | | 69 |
| Bechtel | | 30 |
| GE | | 30 |
| JCWP | | 30 |
| | Subtotal | 229 |
| Contributors | | |
| ESEERCO | | 5 |
| SOHIO | | 5 |
| Program Loan | | 24 |
| | TOTAL COMMITMENT | 263 |

Construction began in December 1981, immediately after project funding was secured. Construction was completed on April 30, 1984, three months ahead of schedule. Final capital costs of the plant were $263 million, approximately $30 million under budget. The plant began commercial production on June 24, 1984 and the Program began a 5-year demonstration phase that same month.

When the Program was formulated in 1979, it was projected that revenues during the proposed 7-year demonstration period would be sufficient to cover operating and maintenance costs and to provide the opportunity for capital recovery by the

Participants. By the early 1980's, the decline and volatility of oil prices had significantly changed the financial outlook and risks of the Program.

Because of these risks, in 1982 Edison and Texaco sought a minimum product price guarantee from the Synthetic Fuels Corporation (SFC) to ensure adequate funds to support Plant operations during the demonstration period. After negotiations with the SFC and pursuant to the terms of the Price Guarantee Commitment (PGC), the SFC agreed to provide up to $120 million for a 5-year demonstration period (Stage I). Edison agreed to acquire the Plant and operate it for a 15-year period (Stage II) subject to: 1) viable commercial operating economics, and 2) favorable regulatory treatment in obtaining operating licenses and permits. The Participants agreed to accept limited capital recovery at the completion of Stage I. Edison agreed to fund operating deficits (not to exceed $30 million) in Stage I in the event of shortfalls between operating costs and Program revenues.

The Price Guarantee Commitment was signed July 28, 1983, by the Cool Water Coal Gasification Participants and the United States Synthetic Fuels Corporation. Early in 1986, the U.S. Treasury Department assumed the rights and liabilities of the SFC under the provisions of the PGC.

## Process Description

The Cool Water Coal Gasification Plant, located in Southern California's Mojave Desert, is adjacent to Edison's existing Cool Water Generating Station. It is an integrated coal gasification combined cycle (IGCC) electric power plant with a capacity of 100 Megawatts (MW) net. The major systems are: coal handling units, gasification units (including syngas coolers), particulate removal system, slag handling system, sulfur removal and recovery units, one 65 MW combustion turbine-generator, one heat recovery steam generator (HRSG) and one 55 MW steam turbine-generator.

The plant utilizes an entrained, oxygen blown Texaco gasifier to convert 1,000 tons of coal per day to a medium-BTU synthesis gas (syngas). After particulate and sulfur removal, the syngas is combusted in a gas turbine to produce electricity. Steam is produced by recovering heat from the hot product gas before cleanup in syngas coolers and from gas turbine exhaust in the heat recovery steam generator (HRSG). Steam from both sources is combined and superheated in the HRSG and then utilized in a steam turbine for production of additional electricity; heat recovery is maximized in this manner.

The Program coal is a specified Utah run-of-mine coal ('SUFCO') with approximately 0.4 weight percent sulfur. The Program has also successfully tested two high-sulfur Eastern United States coals for short durations in early 1986: Illinois #6 coal (containing 3.1 weight percent sulfur) and Pittsburgh #8 coal (containing 2.9 weight percent sulfur).

Actual performance data for the three coals tested to date are reflected below:

PLANT PERFORMANCE/DESIGNED FEEDSTOCKS
(AT 1,000 TPD THROUGHPUT)

| | DESIGN | ACTUAL PERFORMANCE | | |
|---|---|---|---|---|
| COAL | SUFCO | SUFCO | ILL. #6 | PITTS. #8 |
| SULFUR CONTENT (WT. %) | 0.48 | 0.4 | 3.1 | 2.9 |
| OXYGEN CONSUMPTION (TONS/DAY) | 1000 | 908 | 885 | 1004 |
| GROSS POWER PRODUCTION (MW) | 114 | 116 | 120 | 129 |
| BY-PRODUCT SULFUR PRODUCED (TONS/DAY) | 4.6 | 3.8 | 30.0 | 27.0 |
| CARBON CONVERSION (%) | 95.0 | 98.3 | 97.2 | 97.8 |
| GASIFIER REFRACTORY LIFE (YRS.) | 1 | 4 | 2 | 2 |
| OVERALL HEAT RATE (BTU/KWH) | 11,510 | 11,550 | 11,700 | 11,460 |

## Environmental Excellence

The Cool Water Coal Gasification Plant, currently completing the third year of its 5-year commercial demonstration, has proven that integrated gasification combined-cycle (IGCC) technology can reliably produce electrical power while limiting emissions of $SO_2$, $NO_x$ and particulates to a rate only one-tenth of the federal new source performance standards for coal-fired electrical generating plants. The solid effluent streams at Cool Water include a slag that has been declared nonhazardous by the EPA and the State of California (commercial markets are being sought for the slag) and a 99.5% pure elemental sulfur which has been sold since initial operation. Process water requirements are 40% less than those of a conventional coal-fired utility plant equipped with flue-gas desulfurization units for stack gas scrubbing thus reducing waste water treatment requirements.

The IGCC technology employed at Cool Water has now been demonstrated to efficiently convert coal to electricity in an environmental superior fashion (the table below depicts the emission levels for each of the three coals tested to date).

HRSG Emissions - Lbs./MMBtu

| | Permit Limit[1] | SUFCO 1985 EPA Test | Ill. #6 EPA Test | Pitts. #8 Source Test | Federal NSPS[2] |
|---|---|---|---|---|---|
| $SO_2$ | 0.16 | | 0.068 | 0.087 | 0.6[3] |
| $SO_2$ | 0.033 | 0.018 | | | 0.24[4] |
| $NO_x$ | 0.13 | 0.07 | 0.094 | 0.09 | 0.6[3] |
| CO | 0.07 | 0.004 | 0.004 | <0.002 | NS[5] |

Notes:

[1] Emission limits from EPA Permit.

[2] New Source Performance Standards for a coal-fired power plant burning equivalent coal as CWCGP.

[3] Emissions controlled to 0.6 lb./MMBtu (eastern states limits).

[4] 0.8 lbs./MMBtu uncontrolled emissions x .30 for controlled emissions (western states limits).

[5] NS: No Standard

$SO_2$ emissions are typically 10 to 20% of the allowable levels under the U.S. EPA New Source Performance Standards. Sulfur removal from the syngas has ranged between 90 and 97%. Overall sulfur recovery from coal is typically 97%.

Stack emissions of $NO_x$ and particulates have also averaged about 10% of allowable levels under the U.S. EPA New Source Performance Standards.

## Economics

When the oil embargo hit the United States (as well as other nations) in 1973, the importance of developing alternative methods of power generation was dramatically brought home. Skyrocketing prices and diminishing supplies of natural gas and oil made it clear that alternate fuel sources/technologies needed to be explored. Environmental concerns further dictated the need to utilize alternative fuels in a manner least impacting the atmosphere. The decision to pursue the Cool Water plant development was made with this need in mind.

By the time the Cool Water Coal Gasification plant was authorized for construction, the operating economics had become uncertain due to a highly volatile energy market. Sizable first-of-a-kind costs, both for engineering and installed equipment, were being projected for the commercial demonstration of the IGCC technology. The Participants decided to reduce capital risks by agreeing to minimize costs in every way possible without significantly impacting the ability to meet the overall Program objectives. For example, the plant was designed for an 11,300 Btu/kWh heat rate in order to reduce front-end capital costs.

This decision eliminated the employment of a reheat steam turbine which could have made a significant improvement in the operating economics. However, no compromises were made in the overall design configuration that would not allow a full-scale demonstration of the IGCC technology.

The plant as finally constructed is a single module commercial gasifier ideally suited for demonstration testing. By operational objective, it incorporates many test and demonstration activities into the Program, which add atypical costs into the overall production cost equation. These costs, together with the sacrifices in operating efficiencies to minimize front-end capital costs, have precluded this first-of-a-kind plant from achieving commercially competitive production cost rates. However, recent EPRI studies indicate that the process utilized at Cool Water will produce power in a mature plant for approximately 10% less than a direct coal-fired plant with scrubbers.

The EPRI studies show that a commercial IGCC plant of 250 MW or greater (providing some economics of scale) could be built with existing technology to attain a heat rate of 9000 Btu/kWh based on the higher heating value of the coal feedstock. Such a plant could be constructed for essentially the same cost/kWh as a conventional pulverized coal plant. It would have greater efficiency and it would be far superior in the area of environmental emission.

In regards to Cool Water, as the plant heads toward commercial operation (post-1989), energy prices show little sign of increasing to the required level to generate a positive net revenue. Commercial operation in Stage II now appears to be economically imprudent.

Under the terms of the SFC price support contract, Edison has the right to request a waiver of its obligation to acquire and operate the facility if Stage II operation is uneconomical. The United States Treasury Department would review such a request to determine whether such waiver would or would not be granted. After extensive and careful evaluation, Edison has requested such a waiver from the Treasury for post June 1989 commercial operation of the single-train Cool Water plant. The factors cited by Edison include the current and forecast prices of competing energy sources, together with a current and projected overabundance of electric power generation capacity from third party co-generation projects in the State of California. Edison's analysis had to be made in advance of the June, 1989, completion of the Cool Water demonstration period in order to allow adequate time to apply for commercial operating licenses and permits from the appropriate regulatory agencies if commercial operation were feasible.

## Future Considerations

The U.S. electric utility industry has a combined coal-fired generating capacity of some 250,000 MW, accounting for 55% of net electricity generation. It consumes approximately 650 million tons of coal, over 84% of U.S. coal consumption. The prime motivating factors for the industry's growing dependence on coal are its abundance throughout the U.S., supply and price security, and low cost.

Despite these positive characteristics, there are several inherent limitations in coal use: it is bulky; expensive to transport and store; and most importantly conventional coal combustion results in substantial environmental emissions. As concerns about the environment increase and regulations on permissible emissions become more stringent (especially $NO_x$ and $SO_2$ impacting the acid rain issues), coal consumption in existing as well as new generating plants will be constrained.

The technology being proven at Cool Water is in reality a national asset:

1. The environmental performance has been outstanding. The plant has demonstrated its ability to limit emissions of Sulfur Dioxide, Nitrogen Oxides, and Particulates to 10% of the allowable levels under the U.S. EPA's New Source Performance Standards for coal-fired electrical generating plants.
2. The technology is equally attractive in new power plant construction and the retrofit of existing units.
3. The technology is cost competitive with conventional forms of electric power generation.

Integrated gasification combined-cycle is a proven technology which has successfully demonstrated that coal-to-electricity conversion need not be dirty nor prohibitively expensive. It offers additional advantages, which taken together, makes IGCC a strong candidate for future utility applications world wide.

To date, over 50 utilities have visited the Cool Water site to learn more about IGCC operations. Over ten of these utilities are conducting site-specific studies based on the Cool Water design. Potomac Electric Power Company, for example, has announced plans to construct a phased IGCC with the initial phase coming on-line in the early 1990's, and the final gasification phase slated for 1997.

The rationale to continue to operate Cool Water is national in perspective. Long-term demonstration at Cool Water, using Eastern high sulfur coals, is consistent with the objectives of proposed legislation such as S. 85 (since the technology, in modular form, is compatible with gas, oil, and/or coal fuels) and S. 879, since the long-term testing of Eastern coals would provide the data on plant reliability and environmental performance which is necessary for utilities beneficially to use a new, improved option for generating electric power economically.

Cool Water is a single train, 100 MW demonstration plant consisting of one commercial module using early 1980's technology. Commercial plants will be larger, multi-train units employing the latest technology. This will inherently give them lower capital costs, improved reliability, and higher efficiency at both full and partial loads.

Much has been learned from Cool Water, and many improvements have been made, but several potential improvements requiring capital expenditures were not incorporated since they could not be justified in the short remaining life of the demonstration program. Additionally, capital cost cutting steps were taken in the design phase, sacrificing efficiency, in areas where we felt we could legimately extrapolate the Cool Water results.

Cool Water has operated on low sulfur western coal during most of the demonstration period. Most commercial plants are expected to use high sulfur eastern U.S. coals. Some important questions remain about the long term effects of high sulfur coals on materials of construction.

Private industry was able to provide the original initiative for Cool Water. As a "national asset," it would be a setback in efforts to develop viable new technologies for addressing acid rain issues and fuel switching if Cool Water were not to continue operating in the near future. Appropriate federal support for long-duration Eastern coal tests and commercial scale demonstration of hot gas cleaning are two examples of how Cool Water can serve this national purpose.

Continued operation would facilitate the accumulation of a larger data base, thus instilling greater utility confidence in the IGCC process. This would encourage the deployment of this new and environmentally benign process. Therefore, it is a national decision as to whether to keep the Cool Water plant on line as an operating test bed until commercial plants are in service.

# H-E PROCESS
(Hydrogenation - Extraction)

## A Method Of Coal Refuse and Oil Shale Conversion

## To

## Liquid Fuel and Electric Power

Testimony Before Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources

ROBERT R. ADDINGTON
EXECUTIVE VICE-PRESIDENT
ADDINGTON, INC.
P.O. BOX 2189
ASHLAND, KENTUCKY 41105-2189
(606) 928-3433

Mr. Chairman and members of the Subcommittee, my name is Robert Addington. I am President of Triad Research, Inc. and Vice-President of Addington, Inc., located in Ashland, Kentucky. Both companies are wholly owned by my brother Larry Addington and myself. I am offering testimony to request $2.5 million of the assistance from the fiscal 1988 budget. These funds are necessary to complete our $7 million development program of the (Hydrogenation-Extraction) Process. To date, approximately $4 million has been expended by us personally, with $3 million required to complete the remaining 5% of pilot plant construction work and one year of operation. The balance of $500,000 will be supplied by us and hopefully the Kentucky Energy Cabinet.

This state of the art process can economically convert the low cost energy inherent in waste coal and "gob" into light, liquid fuel and electric power. In extensive techno-economic evaluation showed that the process can be expected to produce oil from shale at about $15.00 per barrel operating cost by providing 200-250% Fischer Assay yields on Devonian Shale. And approximately one barrel of oil and 47 kilowatts of electric power per ton of coal refuse.

Addington, Inc. is an established coal company with an unparalleled reputation for mining innovation and environmental concern. With over twenty years in this industry, I believe we enjoy a good reputation for responsiveness to community and marketplace needs.

During the oil embargo days of 1973-74 we had great difficulty obtaining diesel fuel for our coal mining equipment. At that time an engineer working for us pointed out their were significant amounts of oil shale in the Eastern United States. A need for fuel oil and the state of the energy market prompted us to investigate the potential of oil shale.

Between 1977 and 1980 we conducted an extensive techno-economic survey of existing and proposed technologies to extract oil from oil shales. Simultaneously, we constructed several simple pilot plants to study how different processes performed on Eastern Oil Shale. In addition, we tested domestic shale samples in Brazil using the Petrobras technology.

Our studies showed that a donor solvent approach had the most merit, but required much development work. Before entering a serious development effort we established the following parameters. A developed process must:

+accept a loose feedstock specification; thus
 reducing preparation costs.
+completely utilize feedstock.
+be a straight forward process, with high efficiency,
 but without the need for extreme process conditions.

+utilize conventional and available refinery equipment.
+eliminate the use of free hydrogen which is extremely costly.
+be commercially viable in a $25 crude market.

The parameters set we began work on an advanced donor solvent concept. We discovered a world-wide R&D company named Chem-Systems was concurrently working on a similar approach. After negotiating, we entered into a joint development contract with Chem-Systems and a laboratory and bench scale program began in earnest. Upon successful completion of this work, which met our development criteria, a pilot plant facility was designed to mock a full scale commercial plant. With the process chemistry proven in the laboratory and in bench scale equipment, before committing to construction of the pilot plant, we designed and constructed a cold-flow model to observe material flow.

At this time, discussion and a visitation by a United States Department of Energy official prompted us to investigate coal and the laboratory and bench scale work continued using coal. We reviewed the many technically successful attempts at coal conversion and discovered that their economic viability was hindered by the expense of the feedstock. Because good coal as a feedstock is a high operating cost expense, processes developed were forced to use extreme conditions to convert large amounts of carbon to liquids. This created expensive equipment trains. The result was processes requiring large capacities and capital requirements to take advantage of economies of scale.

We recognized that for coal conversion to be successful the process had to use an inexpensive feedstock. As coal operators, coal preparation plant refuse and "gob" have always presented an economic and environmental problem. Bench Scale work demonstrated that this nearly free feedstock should perform well in our process.

We estimate that at least 540,000,000 tons of this material has already been deposited in the United States. Further, we estimate that a minimum of 35 million tons of coal refuse is being produced in the United States each year. Serious attention for converting this waste to useable forms of liquid energy should be given more attention.

Our work, much accomplished by outside consultants, shows that in a $24.00 per barrel oil and $0.026/kwh market H-E Process oil shale and coal refuse process plants can be economically viable in plant capacities as low as 5,000 barrels per day and 1500 barrels per day/70MW respectively. At a capital cost of about $175 million.

The last step to demonstrate the overall technical and economic viability of the H-E Process is the successful operation of our fully integrated pilot plant facility located in Ashland, Kentucky. Since 1974, we have spent about $10 million dollars in Energy Research and Development with over $4 million dedicated to the H-E Process. As stated in correspondence to the Subcommitee Chairman we need assistance to complete the pilot plant, which is now 95% complete and to operate it for one year. We estimate the funding requirement to be $3.0 million of which we seek $2.5 million in funds from the Fiscal 1988 Budget.

After full pilot plant demonstration, we believe this technology can make oil shale and coal refuse utilization an attractive investment for the private sector. While the capacity of the pilot plant is 2 tons per day of oil shale and 1 ton per day of coal refuse, the scale up to commercial size is approximately 10:1. Small plants can be constructed quickly, and because of their size, without disrupting the environmental or local infrastructure. Each plant can provide approximately 125 permanent jobs while displacing imported crude. But the data obtained from the operation of the pilot plant is necessary to attract interest from the private sector.

In Summary, extensive work has been accomplished. With the assistance we request in hand, this technology should be ready for the marketplace and can economically displace imported energy in comfortably small or aggressively large increments.

Subcommittee on Energy Research
& Development
of the
Senate Committee on Energy
& Natural Resources

# Hearings on the Clean Coal Technology Program

Statement of Mr. Clay D. Smith
President and Chief Executive Officer
OTISCA Industries, Ltd.
Syracuse, New York

April 2 and 9, 1987

Mr. Chairman and Honorable Members of the Subcommittee, thank you for this opportunity to participate in the hearings on the Clean Coal Program. I offer this statement for the record on behalf of OTISCA Industries, Ltd., located in Syracuse, New York.

## OTISCA FUEL

As a result of over 15 years of research, OTISCA has developed precisely the type of clean-burning, coal-based fuel which the Clean Coal Program was designed to foster. Derived from a new technology for physically cleaning high ash and high sulfur coal, OTISCA FUEL is an ultra-clean, ultra-fine coal water slurry. It can be burned cleanly and efficiently in industrial, commercial, and residential uses, with minimal expense and time required for retrofitting existing fuel-burning equipment. Over 140 tons of OTISCA FUEL have been produced in an existing pilot plant. The fuel has been used in diesel and gas turbine testing by DOE-supported programs.

OTISCA's pioneering efforts to develop an environmentally sound, coal-based fuel were recently recognized by Rep. George Wortley (R-NY) in remarks published in the Congressional Record (February 26, 1987). A copy of those remarks is attached.

**OTISCA FUEL Is Environmentally Sound.** Thorough burn testing of OTISCA FUEL has consistently demonstrated sulfur and ash emissions typical of a fuel with 0.6 percent sulfur and 0.7 percent ash. These levels are competitive with most fuel oils currently in use, and are far below the output produced by traditional methods of burning raw or conventionally-cleaned coal. In addition, no harmful by-products are produced by the OTISCA Process. The largest by-product is a clay-like material which shows promise as a lining material for landfill sites, or as a ceramic raw material.

**Expensive Retrofitting Is Not Required.** The unique breakthrough of the OTISCA Process is that it achieves such low pollution levels without the extraordinary expense associated with conventional "coal-cleaning" methods such as stack scrubbers and fluidized-bed technologies. For example, at a cost of less than $100,000 a typical industrial- or commercial-grade boiler can be retrofitted or repowered to permit the burning of OTISCA FUEL, as well as the semi-automatic switching back of the system to burn conventional fuels.

**Various Types Of Coal Can Be Used.** OTISCA's Process has been applied effectively to a broad range of types of coal, including anthracite, sub-bituminous, and lignite varieties. Thus, OTISCA offers the potential for using much of America's abundant coal reserves as an alternative to traditional petroleum-based fuels. This can be done without harmful effects on the environment, and at a fraction of the cost of traditional "coal-cleaning" technologies.

## Achieving Commercial Acceptance Of OTISCA FUEL

The Clean Coal Program was designed to encourage such breakthroughs as OTISCA FUEL. Congress recognized that the harmful environmental effects of burning raw coal require the development of new technologies for burning coal cleanly. Congress also recognized that public support is necessary for the rapid commercial acceptance of new coal-based fuels. OTISCA's experience in attempting to achieve widespread acceptance of its fuel confirms the great need for the Clean Coal Program in achieving this latter goal.

**FUEL Users Are Reluctant.** Intensive testing in a commercial-scale boiler confirms the viability of OTISCA FUEL as an alternative to traditional fuel oils. Moreover, OTISCA can retrofit existing equipment, and produce and supply its product to consumers, at a cost comparable to that paid for traditional fuels (assuming oil prices at their current levels). What OTISCA has difficulty doing, however, is convincing large-scale commercial and industrial users that OTISCA FUEL is in fact a viable alternative to the fuel oil they are currently using. Even with the savings which OTISCA FUEL offers over the long run, large-scale fuel users are reluctant to "gamble" on a new product.

**Declining Oil Prices Make Alternative Fuels Less Attractive.** This problem has been exaccerbated by the decline in oil prices, which has reduced even further the interest in using alternative fuels. Lower oil prices translate into a smaller incentive to use potentially cost-saving alternatives. It seems illogical that the development and acceptance of proven coal-based fuels should await the day when oil prices are so high that it suddenly becomes "worth the risk" to try a new, cheaper fuel. That is hardly what the sponsors of the Clean Coal Program had in mind.

**Small Businesses Face Added Difficulties.** Another reason OTISCA has had difficulty in achieving widespread acceptance of its fuel is that we are a small company. Our resources -- more than 97% of which have come from private funding -- have been devoted largely to the development and testing of our product. As a matter of both influence in the marketplace and the cost of entering the market, our ability to achieve acceptance by large-scale fuel users is limited.

**Proposed Pilot Program.** OTISCA currently is completing construction of a 15-ton per hour production plant near Syracuse. We hope to obtain funding through the Clean Coal Program for a pilot program in which commercial users will burn the fuel produced by that plant, and prove its commercial viability. OTISCA intends that the public funds will be repaid on a mutually agreeable basis. We are confident that OTISCA has developed the most promising technology anywhere for burning a coal-based fuel cleanly and efficiently, and we hope that this program will be funded to prove that fact.

## How The Clean Coal Program Can Help Companies Like OTISCA

**Encouragement Of Commercial Acceptance.** OTISCA's efforts to achieve widespread acceptance of its fuel in the marketplace show two important aspects of the Clean Coal Program which deserve the

Subcommittee's attention. First, in addition to the development of new clean coal technologies, the Program must also foster the acceptance of those technologies -- and the fuels they produce -- in the marketplace. The traditional use of fuel oils is too well entrenched to simply rely on the proven effectiveness of clean coal technologies to achieve their commercial acceptance.

**Support For Small Business.** Second, the Clean Coal Program should provide special incentives for the development of clean coal technologies by small businesses. This might be done by ear-marking a certain amount or percentage of the Program's funds for projects by small businesses. Too often, smaller companies have insufficient market power to prove the commercial viability of their products, and insufficient political clout to gain funding from government programs. In an area like the development of clean coal technologies, we can ill afford to let worthy projects go unfunded and ignored simply because companies like OTISCA and others lack such power.

I hope these remarks will be useful to the Subcommittee. Again, thank you for the opportunity to submit this statement.

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Congressional Record

## OTISCA INDUSTRIES PRODUCING CLEAN-BURNING, COAL-BASED FUEL THAT CAN CURB ACID RAIN

**HON. GEORGE C. WORTLEY**

OF NEW YORK

IN THE HOUSE OF REPRESENTATIVES

*Thursday, February 26, 1987*

Mr. WORTLEY. Mr. Speaker, with pride, I commend the attention of the Members of this 100th Congress to a technological breakthrough in the development and use of a new clean-burning liquid fuel refined from high ash and high sulfur bituminous raw coal. When used in place of many fuel oils and the conventional burning of raw coal, this fuel can contribute significantly to a reduction of our Nation's acid rain problems at minimal costs for the relatively simple conversion of existing commercial and industrial grade boilers.

Production of this fuel, an ultraclean and ultrafine ground coal water slurry, and the retrofitting techniques for its utilization have been made possible by the engineering skills of Otisca Industries, Ltd., Syracuse, NY.

Thorough burn testing of Otisca fuel shows that the sulfur and ash emission outputs are less than 0.6 percent and 0.7 percent, respectively. These levels are in the range of fuel oils currently in use and are considerably less than the emissions resulting from the burning of coal. In addition, Otisca fuel can be stored like conventional liquid fuels, it is nonflammable, it does not pose the risk of explosion and it burns only when atomized in a burner. Otisca fuel is dust-free, odorless, nontoxic, and easily cleaned up when spilled.

Since 1975, one of our major national goals has been energy independence. To achieve this goal, abundant coal has loomed as an attractive and logical alternative to oil and natural gas. But the stumbling block to the greater use of coal has been the excessive emissions of sulfur dioxide, nitrogen oxide and ash.

During the 99th Congress, 171 Members of this body cosponsored H.R. 4567, the Acid Rain Deposition Act of 1986. More than 185 members cosponsored at least one bill to control acid rain during the past session. As an original cosponsor of H.R. 4567, I was deeply disappointed that this carefully crafted legislation was not dischared by the Committee on Energy and Commerce. Every day that we delay controls which would reduce emissions of pollutants that cause acid rain results in cumulative damage to America's ecological and economic resources. Before the end of this spring, those of us who sought the enactment of H.R. 4567 will introduce another acid rain control bill.

But whether or not this legislation is eventually enacted, the use of Otisca fuel seems ideally suited to help address both the environmental and cost concerns of many of my colleagues, including those concerned with the jobs of workers in coal mining States, the viability of jobs-intensive industries that burn fossil fuels, and the energy costs borne by the consuming public.

Mr. Speaker, during the last 10 years, Otisca Industries has spent more than $6.5 million in private funds to develop its processes. Otisca can already produce and sell its fuel to commercial and industrial users at a savings compared to the costs of conventional fuels. The only problem is that the savings are too small to lure many such consumers to use a new type of fuel. At the savings now available, there just are not enough pioneers who are willing to use a new energy source like Otisca fuel.

In 1984, Congress created the Clean Coal Technology Program to encourage the development of new coal-based fuel, wisely recognizing that public support is sometimes necessary for new ideas and technologies to gain a foothold in the marketplace. In his fiscal year 1988 budget, the President requested Congress to allocate $50 million to the program so that America can continue to move forward to finding economically efficient ways to use its abundant coal as an alternative to importing oil. Otisca Industries has taken a leap forward to achieve this program goal and at the same time has found a more cost effective way to curb acid rain.

I commend the dedicated and innovative work of Otisca's founders, Mr. Clay Smith and Dr. Doug Keller, Jr., and I urge my colleagues to support the furtherance of Otisca's enterprising efforts.

87-4.4

# Implications of Utility Life Extension Programs for the Acid Rain Control Debate

by

Eugene M. Trisko
Executive Vice President
Stern Bros., Inc.

Presented at:

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Air Pollution Control Association
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## INTRODUCTION

When Congress amended the Clean Air Act in 1977 to tighten emission control requirements for new stationary sources, it expected that the more rigorous Revised New Source Performance Standards (NSPS) would produce a long-term declining trend in SO2 emissions as existing, heavily-emitting facilities were replaced by new, tightly-controlled ones.

This long-term downward trend in SO2 emissions is not likely to occur for at least another 20 years. With sharp increases in the costs of new generating capacity in the 1970s and 1980s, and recent technological advances in boiler and turbine refurbishment, electric utilities are finding it more cost-effective to extend the lifetimes of older coal-fired plants than to build new plants which must meet the stringent Revised NSPS. Under current EPA regulations, plant life extension programs generally do not entail new emission control requirements.

The Congressional acid rain control debate is in its seventh year with little prospect of near-term resolution. Concerns about the scientific uncertainties and economic impacts associated with proposed emission control programs have been aired in dozens of hearings since 1980. More recently, conflict has arisen between advocates of programs to promote "clean coal technology" and those favoring immediate acid rain-related emission reductions: one group claims that emissions will decline in the future as utilities adopt advanced combustion and emission control systems on new and existing units, while others insist that federal support for these technologies is not a substitute for more stringent emission controls on existing sources.

A key unresolved issue in these debates is whether an emission reduction program can achieve near-term reductions of SO2 or nitrogen oxide (NOx) emissions without impairing prospects for the development and commercialization of advanced clean coal technologies. This paper concludes that a phased-in approach to emission controls for existing coal-fired powerplants -- triggered when plants reach 30 years of age -- could provide both significant near- and long-term SO2 emission reductions, and allow sufficient time for advanced clean coal technologies to be commercially demonstrated and subsequently retrofitted to coal-fired powerplants. This approach also would close a loophole in the Clean Air Act allowing utilities to extend the lifetimes of powerplants without reducing emissions.

## THREE INTERWOVEN POLICY STRANDS

### The 1977 Clean Air Act Amendments

In the 1977 Clean Air Act Amendments, Congress revised Section 111 of the Clean Air Act to require new coal-fired powerplants to employ the best technological system of continuous emission reduction. 1 This amendment eliminated the use of low-sulfur coal as a compliance option under EPA's previous NSPS for fossil-fired boilers (1.2 pounds of SO2 per million BTU heat input.)

In 1977, Congress anticipated that large increases in SO2 emissions could result from additional powerplant construction under the 1971 NSPS. It sought to avoid these increases through the more stringent Revised NSPS. The 1977 House Committee Report on the 1977 Clean Air Act Amendments stated the environmental justification for the tighter new source standards:

> "Between 1970 and 1980, total SO2 emissions from powerplants with present new source performance standards in effect will double, and triple from 1970 to 1990. This is predicted by the NAS to result in up to 40-percent increases in urban sulfate levels nationwide. ...
> In contrast, FEA calculations show that applications of the committee's proposed NSP standards to only coal-fired powerplants will result in greater than 20 percent decrease in total national sulfur dioxide emissions by 1990." 2

Congress's expectation that the Revised NSPS would produce a declining SO2 emission trend by 1990 was based upon then-prevailing assumptions about electric power growth rates, the future role of nuclear power, and the rate of retirement of existing coal-fired powerplants. Most of the assumptions used in the Federal Energy Administration (FEA) study referred to in the House Committee Report are no longer justified. Forecasts of electric power demand have fallen sharply, nuclear power is no longer considered a viable option for new plants, and life-extension programs are being pursued for existing coal-fired powerplants. 3,4

Utility Life Extension Programs

It generally is cheaper today to keep a 30- to 45-year old coal-fired powerplant on line through life extension than to replace it with new capacity. 3,4 The comparative costs of life extension are so favorable that even a retrofit flue gas scrubber requirement would not tip the balance in favor of new plant construction in many cases. 5,6 Consequently, analysts now assume much longer average plant lifetimes -- typically 60 years -- than the 30 to 45 year lifetime assumptions prevalent in the mid-1970s. 3,5

Longer plant lifetimes will reduce the number of new sources built to replace older, heavily-emitting units which must comply only with National Ambient Air Quality Standards. By the year 2000, some 55,000 megawatts of coal-fired capacity will exceed 40 years of age. 5 These units emitted at an average rate of 3.1 pounds of SO2 per million BTU heat input in 1980, compared to an average SO2 emission rate of 0.8 pounds per million BTU for plants built under the 1971 NSPS. 5

EPA has predicted that utility life extension expenditures usually will not be large enough to trigger application of the Revised NSPS at individual facilities. "In general," EPA concludes, "the economic incentives for life extension relative to new construction appear very large, and we would not expect even a major emissions control program to alter this pattern significantly." 7 In practice, new emission control requirements might act as an inducement to life extension, thereby allowing utilities a longer time period to recover the capital costs of pollution control equipment installed at older plants. 7

The impact of utility life-extension programs on future SO2 emissions has been assessed by the Congressional Research Service (CRS) and the Electric Power Research Institute (EPRI). The CRS concludes that:

"Although SO2 emissions have been declining, analysis of the current situation in the utility industry suggests that significant further declines in future SO2 emissions are doubtful.

... If old plants are retired at their 30-45 year design life, then emissions decreases from retirements could more than offset any increases from new, less-polluting facilities that both replace them and meet new demand. But if old plants are extended to a 60-year life, then emissions will almost certainly not decline significantly and may well rise, with the rate depending on growth of new capacity."3

EPRI concludes that 76 percent of pre-1971 NSPS coal-fired units could be extended to a 60 year service life without increasing national SO2 emissions before 2010. 5 In other words, SO2 emissions would increase between 1985 and 2010 if more than three-fourths of existing plants were refurbished.

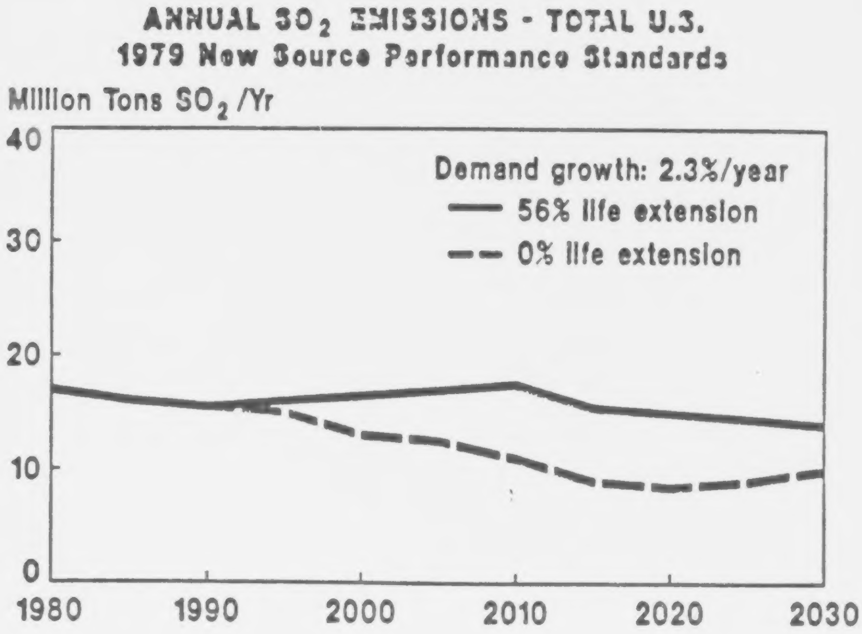
Figure 1 illustrates the emission trend consequences of utility life extension programs. 8 With demand growth at 2.3 percent annually and no life extension programs, EPRI predicts that U.S. utility SO2 emissions would decline steadily from about 16 million tons in 1980 to 10 million tons in 2010, and then rise slightly to the year 2030. With an assumed 56 percent utilization of life extension programs on existing capacity, emissions are forecasted to increase slightly between 1990 and 2010. Life extension programs at this level would increase SO2 emissions in 2010 by roughly 5 million tons over the base case.

## Clean Coal Technology

Federal programs to stimulate clean coal technology are the descendants of earlier subsidy programs directed at fossil-based synthetic fuels development. Federal support for clean coal technology has its roots in national energy policy, as one of a series of efforts aimed at expanding coal´s role in domestic energy markets. More recently, clean coal technology has been directed specifically toward environmental objectives. According to its proponents, clean coal technology is on a collision course with proposed acid rain legislation.

In November 1984, Congress authorized a $750 million clean coal technology reserve program to co-fund clean coal technology projects with private industry. 9 In its first phase solicitation, the U.S. Department of Energy received 176 submissions, and in July 1986 selected nine projects for funding. 10 The initial round of projects will receive $400 million in federal funding, with an additional $600 million contributed by industry and states. A Canadian government agency, Environment Canada, has estimated that these nine projects will reduce SO2 emissions by 64,500 tons per year. 11

Figure 1



Source: Reference 8.

A second DOE solicitation, aimed at emission control retrofitting and utility repowering projects, elicited 140 responses last summer. 10

In 1985, industry groups began to tout clean coal technology as a cost-effective weapon against expected future SO2 emission increases. 12 Utility and coal groups maintain that advanced combustion and emission control technologies will achieve SO2 control superior to that required by the Revised NSPS, or at a much lower cost per ton of SO2 removed compared to current methods. These advanced technologies are potentially applicable to new sources and to existing plants repowered for life extension.

The environmental-protection policy rationale behind clean coal technology was boosted by the January 1986 "Joint Report of the Special Envoys on Acid Rain." 13 The "Lewis-Davis" report was an initial effort to structure a bilateral U.S.-Canadian response to the acid rain issue. It called for a $5 billion, five-year clean coal technology demonstration program to be funded equally by the U.S. Government and private industry. The report recommended several technical criteria for project selection, including cost-effectiveness of emission controls, emphasis on technologies applicable to plants burning high-sulfur coals, and a preference for projects which would reduce U.S.-Canadian transboundary pollution.

The U.S. commitment to the Lewis-Davis recommendations has been questioned sharply by Canada in the wake of President Reagan's 1988 budget proposal. 11 The budget claimed that federal, state, and private clean coal technology programs currently authorized or underway in this country fulfilled the Lewis-Davis program recommendations; in short, that no new federal funding was needed for the United States to comply with the Lewis-Davis recommendations. 14

U.S. environmental interests also have attacked the clean coal program as an ineffective substitute for acid rain control legislation. They maintain that the "carrot" of federal clean coal funding will not reduce emissions without the "stick" of emission reduction tonnage timetables in proposed acid rain bills:

"Passage of acid rain control laws in this Congress will insure that industry treats the potential for use of emerging controls as a serious matter. Confronted with the need to plan for a real emission reduction program, the industry will have a genuine incentive to pool the resources required to provide prompt answers to reduce any technical risks associated with emerging technologies.

In contrast, if acid rain control schedules were linked to some unspecified level of proof that new technologies were demonstrated, the industry would have an enormous incentive to delay such demonstrations and to characterize the results of any demonstrations as not sufficiently conclusive." 15

On March 18, 1987, the Reagan Administration announced its support for full federal funding of the clean coal technology demonstration program recommended by the Lewis-Davis report, amounting to $2.5 billion over a five year period. The Administration's policy reversal came one month before a scheduled summit between President Reagan and Canadian Prime Minister Mulroney, whose conservative government has been criticized for its failure to achieve a more stringent U.S. commitment to emission controls.

## LINKING CLEAN COAL TECHNOLOGY AND ACID RAIN CONTROL: THE 30-YEAR/1.2 POUND SO2 CONTROL OPTION

### Clean Coal Technology Commercialization

Acid rain control proposals typically impose uniform deadlines for emission reductions: S.321, the acid rain bill introduced in 1987 by Sen. George Mitchell, would require a 12 million ton reduction of SO2 emissions and a 4 million ton reduction reduction of NOx emissions from 1980 levels by January 1, 1996. The Proxmire-Simpson bill, S.316, has a two-phased approach, with states meeting a 2.0 pound SO2/MMBTU average statewide emission rate for existing sources by January 1, 1993, and a 1.2 pound SO2/MMBTU average rate by December 31, 1997.

These emission reduction deadlines fall close on the heels of the expected commercial demonstration dates for most clean coal retrofit technologies. Figures 2 and 3 summarize the National Coal Council's report to the Secretary of Energy on the commercial readiness and market potential of various clean coal retrofit technologies. 16 Figure 2 covers utility retrofit SO2 control technologies removing 25 to 60 percent of SO2 emissions, and Figure 3 lists retrofit technologies capable of achieving Revised NSPS SO2 (70 to 90 percent removal) and NOx control (0.6 pound NOx/MMBTU).

In view of: 1) the very short leadtimes between initial commercial readiness of most clean coal technologies and the deadlines required by typical acid rain bills; 2) the historic, and well-grounded conservatism of the electric utility industry in applying new technologies - stemming from the need for system

Figure 2

### Clean Coal Technology
### Comparative Rating Sheet
### CASE 1

Case No. : 1
Application Coal Retrofit
Type : Utility
$SO_2$ Control : 25% to 60%
$NO_x$ Control : None

| STATUS | POTENTIAL | CRITERIA | RATING |
|---|---|---|---|
| C) Commercial | 1) Very low | C) Cost-Effectiveness | – negative |
| D) Demonstrated | 2) Low | W) Waste Disposal | o neutral |
| P) Pilot Plant | 3) Moderate | A) Wide Applicability | + positive |
| L) Laboratory | 4) High | | |
| I) Idea/Concept | | | |

| TECHNOLOGY OPTIONS | DEVELOP STATUS | COMMERCIAL READY DATE | COMMERCIAL POTENTIAL SHORT-TERM | COMMERCIAL POTENTIAL LONG-TERM | CRITERIA RATING C | CRITERIA RATING W | CRITERIA RATING A | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| A. PRE-COMBUSTION | | | | | | | | |
| 1. Phys. Cleaning of Fine Coal | C | 1986 | 4 | 4 | o | o | o | ★ |
| 2. Chemical/Biological Cleaning | P | 1995 | – | 2 | – | o | + | |
| B. COMBUSTION/CONVERSION | | | | | | | | |
| 1. Micronized Coal | P | 1990 | 1 | 3 | – | + | o | with cleaning |
| 2. Coal-Water Slurry | P | 1990 | 2 | 3 | – | o | o | with cleaning |
| 3. Two-stage Slagging Combustion | P | 1992 | – | 2 | o | + | o | |
| 4. Sorbent Injection | P | 1990 | 4 | 3 | o | – | + | |
| 5. Atmospheric FBC | D | 1988-90 | 2 | 3 | o | + | + | |
| 6. Pressurized FBC | P | 1992 | – | 2 | – | + | + | More MW |
| 7. Gasification Combined Cycle | D | 1986-90 | 1 | 1 | – | + | + | More MW |
| C. POST-COMBUSTION | | | | | | | | |
| 1. Conventional Wet FGD | C | 1986 | 2 | 2 | – | – | + | |
| 2. Spray Dry FGD | C | 1986 | 4 | 3 | o | – | + | |
| 3. Advanced Wet FGD | D | 1990 | 2 | 4 | – | + | + | |
| 4. Dry Injection FGD | P | 1990 | 3 | 4 | + | – | + | |

★May need other options.

Source: Reference 16.

Figure 3

### Clean Coal Technology
### Comparative Rating Sheet
### CASE 7

| | |
|---|---|
| Case No. | : 7 |
| Application | : Coal Retrofit |
| Type | : Utility |
| $SO_x$ Control | : 70% to 90% |
| $NO_x$ Control | : NSPS |

**STATUS**
C) Commercial
D) Demonstrated
P) Pilot Plant
L) Laboratory
I) Idea Concept

**POTENTIAL**
1) Very low
2) Low
3) Moderate
4) High

**CRITERIA**
C) Cost-Effectiveness
W) Waste Disposal
A) Wide Applicability

**RATING**
– negative
o neutral
+ positive

| TECHNOLOGY OPTIONS | DEVELOP. STATUS | COMMERCIAL READY DATE | COMMERCIAL POTENTIAL SHORT-TERM | LONG-TERM | CRITERIA RATING C | W | A | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| A. PRE-COMBUSTION | | | | | | | | |
| 1. Phys. Cleaning of Fine Coal | C | 1986 | 4 | 3 | o | o | o | with other options |
| 2. Chemical/Biological Cleaning | P | 1995 | – | 3 | – | o | – | |
| B. COMBUSTION/CONVERSION | | | | | | | | |
| 1. Micronized Coal | P | 1990 | 1 | 3 | – | – | o | with other options |
| 2. Coal-Water Slurry | P | 1990 | 1 | 3 | – | o | o | with other options |
| 3. Two-stage Slagging Combustion | P | 1992 | – | 3 | o | + | o | with other options |
| 4. Sorbent Injection | P | 1990 | 2 | 3 | o | – | + | with other options |
| 5. Low $NO_x$ Combustion | D | 1988 | 4 | 4 | o | o | + | with $SO_x$ control |
| 6. Sel. Noncatalytic Red. of $NO_x$ | D | 1990 | 2 | 2 | o | o | o | with $SO_x$ control |
| 7. Atmospheric FBC | D | 1988-90 | 3 | 4 | o | o | + | |
| 8. Pressurized FBC | P | 1992 | – | 3 | o | o | + | More MW |
| 9. Gasification Combined Cycle | D | 1986-90 | 2 | 2 | – | + | + | More MW |
| C. POST-COMBUSTION | | | | | | | | |
| 1. Conventional Wet FGD | C | 1986 | 4 | 3 | o | – | + | with $NO_x$ control |
| 2. Spray Dry FGD | C | 1986 | 3 | 2 | + | – | – | with $NO_x$ control |
| 3. Advanced Wet FGD | D | 1990 | 4 | 4 | + | + | + | with $NO_x$ control |
| 4. Dry Injection FGD | P | 1990 | 2 | 3 | + | – | – | with $NO_x$ control |
| 5. Combined $SO_x$/$NO_x$ Removal | P | 1995 | – | 2 | – | – | + | |
| 6. Sel. Catalytic Red. of $NO_x$ | D | 1990 | 3 | 4 | o | o | + | with $SO_x$ control |
| D. COMBINED TECHNOLOGIES | | | | | | | | |
| 1. B4 + B5 + C4 | I | 1990 | 3 | 4 | o | – | o | |
| 2. B5 + C1 | I | 1988 | 4 | 3 | o | – | o | |
| 3. B5 + C3 | I | 1990 | 3 | 4 | o | + | o | |
| 4. C3 + C6 | I | 1990 | 3 | 4 | – | + | o | |

Source: Reference 16.

reliability, predictable equipment costs and performance, etc., and 3) the desire of environmental interests to secure significant, short-term emission reductions, it appears probable that acid rain control bills like S.316 and S.321 would preclude the use of many clean coal technologies. In this respect, current acid rain control bills may be inconsistent with the principles agreed to by the United States and Canada in the Lewis-Davis report, which called for a major clean coal technology demonstration program as a first step in a bilateral program to control acid rain.

## The 30-Year 1.2 Pound Control Option

Prompted by concerns about the costs and coal market impacts of previous acid rain control bills, analysts have begun to evaluate emission control options tied to powerplant service lives. 17,18,19 The "30-year/1.2 pound SO2" option has emerged from these studies as an approach which offers cumulative SO2 emission reductions comparable to other acid rain bills, at much lower costs and with less severe coal market disruptions. The 30-year/1.2 pound option would require existing powerplants to meet a 1.2 pound SO2 emission rate as they reach 30 years of age. Because it extends compliance dates for most plants into the late 1990s or early 2000s, this approach appears well suited for integration with a large-scale clean coal technology demonstration program.

The concept of tying emission controls to powerplants based on age of service is embodied in the new Mitchell acid rain bill, which would limit individual powerplant emissions to 0.9 pound SO2/MMBTU as plants reach 30 years of age, commencing in 1996. 20 However, the 30-year control requirement is used here to control future emissions increases following a 12 million ton SO2 reduction in 1996. With this huge initial reduction, the bill is criticized for its high compliance costs and adverse effects on clean coal technology development. 10

EPA has compared the costs, electric rate impacts, emission reductions, and coal market effects of a 30-year/1.2 pound SO2 control option with those of H.R. 4567, the acid rain bill introduced in 1984 by Rep. Henry Waxman and more than 160 cosponsors in the House of Representatives. H.R. 4567 was a two-phase proposal, requiring states to achieve average statewide SO2 emission rates of 2.0 pound by 1993, and 1.2 pound by 1997 (hereafter referred to as 2.0/1.2 pound). H.R. 4567 served as the model for S.316, the Proxmire-Simpson bill introduced in the Senate in 1987.

Utility Compliance Costs and Rate Impacts

Table 1 summarizes the present values of utility compliance costs under H.R. 4567 and 30-year/1.2 during 1995-2010 under two compliance options: a "flexible" program with intrastate emissions trading among existing sources, and a "default" case requiring individual plants to meet a 1.2 pound standard. The cumulative SO2 emission reductions associated with these approaches are also shown.

Table 1. Present value of utility costs to comply with H.R. 4567 and a 30-year/1.2 pound control option, 10 percent real discount rate, 1995-2010, and cumulative SO2 emission reductions with alternate implementation strategies

| Option | Billions of early 1985 dollars | Cumulative SO2 emission reductions, 1995-2010 (million tons) |
|---|---|---|
| H.R. 4567 (2.0/1.2) | | |
| Flexible | $6.0 | 100 |
| Default | $19.0 | 150 |
| 30-Year/1.2 | | |
| Flexible | $5.0 | 119 |
| Default | $10.0 | 122 |

Source: Reference 21.

The 30-year option costs 17 percent less than H.R. 4567 in the flexible implementation cases, and reduces 19 percent more SO2 over the 1995-2010 period. The 30-year/1.2 pound plan costs roughly half as much as H.R. 4567 in the default implementation scenario, but removes somewhat less SO2. EPA believes that plant-by-plant default compliance with a 1.2 pound limit under H.R. 4567 is more likely than flexible implementation, while the 30-year/1.2 pound option would lend itself well to flexible emissions trading schemes. 21

The electric rate impacts of the two options are given in table 2 for seven high-impact states in the year 2000 under "traditional utility revenue requirements," or the statewide average rate increases needed to recover implementation costs of the two proposals.

Table 2. Comparison of state average electricity rate increases, H.R. 4567 and 30-year/1.2 pound control option, traditional revenue requirements basis, seven high-impact states, 2000

| State | Flexible implementation |  | Default implementation |  |
|---|---|---|---|---|
|  | H.R.4567 | 30 year/1.2 | H.R.4567 | 30 year/1.2 |
|  | (In percent) |  |  |  |
| Pennsylvania | 5.5 | 2.7 | 5.7 | 2.7 |
| West Virginia | 7.5 | 1.7 | 12.9 | 4.8 |
| Georgia | 2.8 | 0.1 | 5.5 | 1.4 |
| Ohio | 5.5 | 2.6 | 10.8 | 4.8 |
| Illinois | 2.8 | 0.4 | 5.3 | 1.9 |
| Indiana | 9.0 | 2.9 | 14.5 | 6.9 |
| Kentucky | 5.4 | 1.1 | 10.4 | 2.8 |

Source: Reference 21.

In an analysis of emission control costs for the American Electric Power System, a large midwestern coal-fired utility system, ICF estimated that AEP's rates would increase by 1.0 percent in 2000 under the 30-year/1.2 pound option, and by 2.1 percent under a 2.0/1.2 pound statewide average emission rate. 19 By 2010, AEP's rates would increase by 2.6 percent under 30-year/1.2, and by 2.0 percent under the 2.0/1.2 pound option. Rates tend to increase between 2000 and 2010 with the 30-year/1.2 option because additional plants become subject to emission controls during this period.

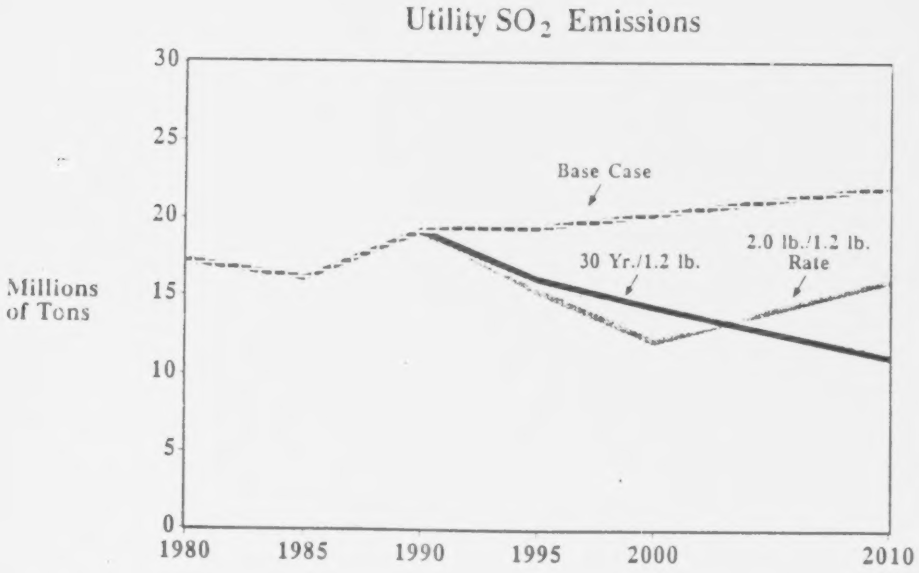
### SO2 Emission Reduction Potential

As indicated in Table 1, the cumulative SO2 emission reductions resulting from the 30-year/1.2 pound option are comparable or superior to those associated with H.R. 4567.

The difference in the timing of these reductions is shown in Figure 4: 30-year/1.2 steadily reduces SO2 after 1995, as more plants reach the 30-year compliance trigger, while the 2.0/1.2 pound statewide option reduces emissions up to 2000 and then falls off as new source emissions below 1.2 pound are added to state emission inventories. 22 By the year 2010, 30-year/1.2 would reduce SO2 emissions by some 11 million tons compared to the base case, while the 2.0/1.2 pound statewide average plan would achieve roughly a 6 million ton reduction.

Figure 5 is a rough timetable for compliance with the 30-year/1.2 pound option: by 1990, roughly one-fourth of fossil-fired generating capacity will be 30 or more years old; by 2000, roughly one-half will be 30 years or more, and by 2010

Figure 4



Source: Reference 22.

about 85 percent will have reached 30 years of age (the remaining 15 percent of capacity would be subject to the NSPS or Revised NSPS, and would not be affected by the 1.2 pound limit.) 23

The effective date of the 30-year/1.2 standard would determine the proportion of generating capacity immediately subject to the 1.2 pound SO2 standard, and the short-term emission reductions it would yield. If a 1995 commencement date were chosen, approximately 3.5 million tons of SO2 emissions would be reduced in that year (Figure 4), affecting one-third of existing capacity (Figure 5). The emission reductions achieved under the 30-year/1.2 option are phased-in over a longer time period than other acid rain control bills. This gradual phasing over a period of roughly 15 years accounts for both the relatively low compliance costs and modest coal market impacts of the 30-year/1.2 approach.

## NOx Control Potential

The 30-year/1.2 pound concept could be expanded to address NOx control as well. Low-NOx burners capable of reducing emissions to less than 0.6 pound NOx/MMBTU are commercially available now for most retrofit applications other than cyclone boilers. To date, no formal estimates have been made of the magnitude or costs of NOx reductions under a 30-year/0.6 NOx approach. However, EPA has estimated that the 0.6 pound statewide average NOx provisions in H.R. 4567 would reduce 1.7 to 2.4 million tons of NOx by 2000, at a cost of approximately $300 million per year. 21 Comparable reductions should be attainable with a 30-year/0.6 pound NOx requirement.

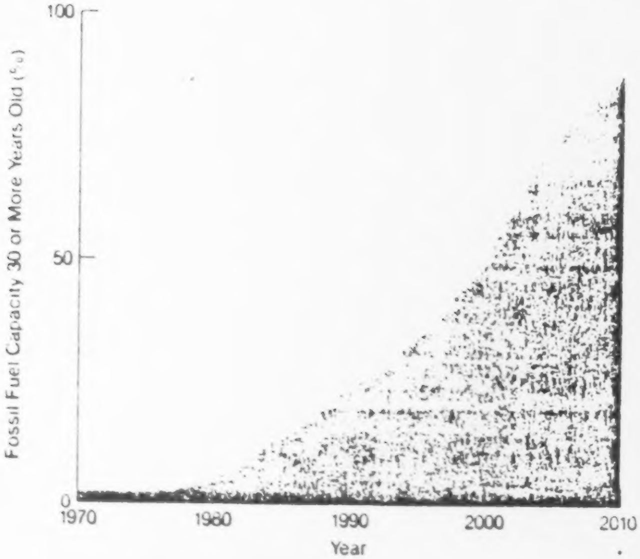
## Coal Market Impacts and Role of Clean Coal Technologies

The 30-year/1.2 pound option avoids the severe coal market disruptions predicted to occur under other acid rain control proposals. Its implementation period is stretched into the early 2000s, a period in which major new additions to electric generating capacity are forecasted, and when virtually all currently-developing clean coal technologies should be fully commercialized and available for use.

High-sulfur coal production forecasts are shown in Table 3 for the years 1995 and 2000 under the 30-year/1.2 option and a 2.0/1.2 pound statewide average requirement. In the worst case (default), the 30-year/1.2 pound option would maintain high-sulfur production at 1984 levels in the year 2000, following a temporary 18 million ton per year decline from 1984 production in the year

Figure 5

Fossil-fuel capacity 30 or more years old



Source: Reference 23.

1995. In contrast, the 2.0/1.2 pound default option risks the loss of 50 million tons of annual production in 2000 (272 million tons versus 322 million tons), and nearly 70 million tons in 1995 (237 million tons versus 305 million tons).

Table 3. High-sulfur coal production forecasts in the midwest and northern Appalacnia under 30-year/1.2 pound and 2.0/1.2 pound statewide average options, alternative implementation scenarios, 1995 and 2000

| Option | Midwest and northern Appalachian coal production (millions of tons per year) | | |
|---|---|---|---|
| | 1984 Base | 1995 | 2000 |
| 30-year/1.2 | | | |
| Flexible | 323 | 316 | 349 |
| Default | 323 | 305 | 322 |
| 2.0/1.2 statewide | | | |
| Flexible | 323 | 309 | 308 |
| Default | 323 | 237 | 272 |

Source: Reference 22.

## INTEGRATION OF 30-YEAR/1.2 POUND WITH CLEAN COAL TECHNOLOGY DEMONSTRATION AND UTILITY LIFE EXTENSION PROGRAMS

Legislation has not yet been introduced combining a long-term emission control plan with the recommendations of the Lewis-Davis report. Nor has Congress responded to the utility life extension phenomenon by extending New Source Performance Standards to sources which repower or refurbish for life extension. Instead, Congress seems once again unable to solve the acid rain puzzle, and increasingly concerned about the impact of proposed acid rain control plans on the development of new clean coal technologies.

The seeds of a potential congressional compromise appear to be present in these three variables: an expanded clean coal technology demonstration program as the first step in a bilateral program to address the U.S.-Canadian acid rain problem; utility life extension programs as a cause of future increases in emissions, and as an opportunity for the demonstration of advanced clean coal technologies, with near-term emission reduction potential; and the 30-year/1.2 pound control plan (with related NOx controls) as an illustrative mechanism for gradually reducing emissions from existing powerplants in a timeframe suitable for the application of newly-developing technologies.

These policy considerations suggest the potential for a two-phase approach to clean coal technology demonstrations and acid deposition control:

>Phase I - Consisting of a $5 billion or similar clean coal technology demonstration program, co-funded by industry and the federal government over a five year period, incorporating the technical project selection criteria recommended by the Lewis-Davis report, namely -

> >Potential for largest emission reductions, measured as a percentage of SO2 or NOx removed
>
> >Demonstration of retrofit technologies applicable to the largest number of existing sources, especially sources that contribute to transboundary U.S.-Canadian air pollution
>
> >Special consideration to technologies applicable to facilities currently dependent on the use of high-sulfur coal.

>Phase II - A 30-year/1.2 pound SO2/0.6 pound NOx emission control requirement (or similar phased-in plan) commencing at the close of Phase I (e.g., 1995), requiring existing sources 30 or more years of age to reduce emissions to these levels (with or without emissions trading between sources.)

Linking a first phase clean coal technology demonstration program to a second phase emission control plan would create strong incentives for industry to accelerate the development of clean coal technologies, with the expectation of their substantial application in the second phase. With the stretched-out compliance dates in a 30-year control approach, sufficient time would be available for these technologies to be thoroughly tested on a number of sources before emission control decisions for many specific plants were made. Also, the 30-year compliance trigger date is sufficiently close to utility life extension scheduling that many plants may be refurbished or repowered at the same time that emission control systems or equipment are added.

## INTEGRATION WITH THE CLEAN AIR ACT

The 30-year/1.2 pound option responds to the utility life extension phenomenon by recognizing that "new" sources today are often "old" sources which have been modernized, and generally are exempt from New Source Performance Standards. It extends the 1.2 pound SO2 control standard developed for new sources in 1971 - after extensive deliberation by EPA about its technical and economic feasibility - to older sources which are now regarded as major contributors to acid deposition, and which increasingly are candidates for life extension programs. It also recognizes that technological approaches to emission control may not be appropriate for many older sources, especially those with site limitations or other engineering constraints, and thus avoids the high compliance costs of "technology-forcing" emission control plans.

In sum, the 30-year/1.2 pound option:

1) Closes a loophole in the Clean Air Act created by life extension programs;

2) Is consistent with the development of an expanded clean coal technology demonstration program, and

3) Reduces emissions in a manner comparable to other acid rain control proposals, at a lower cost to utilities, and with smaller coal market impacts.

As the linkages among these issues are more closely examined by Congress - and there are growing signs that utility life extension is a source of concern to lawmakers - the "collision course" between acid rain control and clean coal technology may be averted.

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STATEMENT OF GARY D. SMITH
SPECIAL ASSISTANT TO THE DEAN
THE UNIVERSITY OF TENNESSEE SPACE INSTITUTE
TULLAHOMA, TN 37388-8897

ON BEHALF OF

THE MHD INDUSTRIAL FORUM
1725 DESALES STREET, N.W.
WASHINGTON, D.C. 20036

TO THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
WASHINGTON, D.C. 20510
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Magnetohydrodynamics (MHD) is the 'high tech' of coal technology. MHD is the energy conversion technology which holds the potential of achieving the highest plant efficiencies while exceeding all standards for environmental intrusion without additional expensive exhaust gas cleanup systems.

MHD is a process currently being developed by the Department of Energy whereby the energy resulting from the combustion of fossil fuel is directly converted into electrical energy without the intermediate mechanical step required in a conventional electrical generation plant. The principle is simple. When a conducting wire is passed across a magnetic field, an electrical current is produced resulting in a conventional electric power generator. In the MHD process, the wire is replaced by an electrically conducting gas called a 'plasma'. The hot gas exhausted from the MHD generator is of sufficient temperature to power a conventional steam plant. The result is an MHD/steam combined cycle power plant (Figure 1) that can produce 50%+ more electrical power than a conventional steam power plant, and can use any grade of U.S. coal.

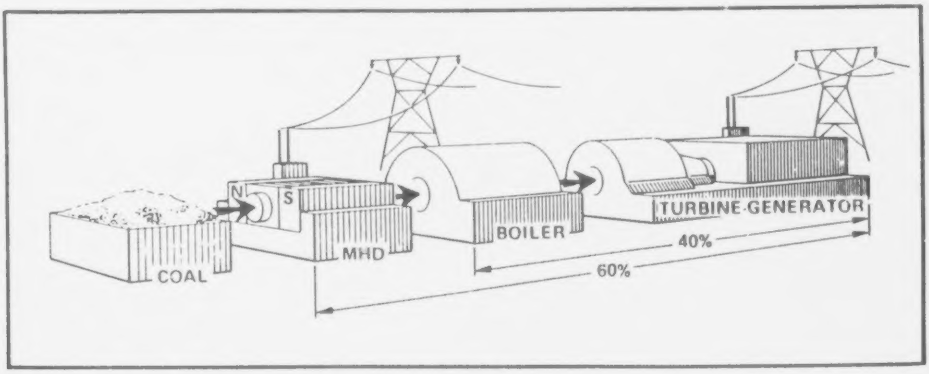


Figure 1. MHD/Steam Combined Cycle Power Plant.

Conventional coal-fired power plants burning high- or medium-sulfur coal require flue gas scrubbers to reduce the sulfur dioxide emissions to acceptable levels. MHD plants eliminate the need for scrubbers since the potassium seed material, used to enhance the conductivity of the combustion gas, acts as a sulfur scavenger to remove the sulfur dioxide. Virtually all of the $SO_2$ can be removed from the exhaust gases. Furthermore, emissions of nitrogen oxides ($NO_x$) from the MHD system are reduced to levels well below mandated standards using a staged-combustion technique. Either an electrostatic precipitator (ESP) or a baghouse, both standard state-of-the-art equipment for coal-fired power plants, can control MHD system particulate emissions to below mandated levels. Finally, the increased efficiency of the MHD system results in reduced emissions of all pollutants, including carbon dioxide ($CO_2$) which is thought to be a major contributor to the 'greenhouse effect' that is attracting the attention of scientists today. The higher efficiency of MHD energy conversion will also result in reduced thermal pollution - both water and air - and reduced cooling water requirements.

Coal-fired MHD plants have experimentally verified levels of sulfur dioxide ($SO_2$), oxides of nitrogen ($NO_x$), and particulate emissions well below the New Source Performance Standards of 1979 (see Figure 2) without using the expensive exhaust gas cleanup systems required on conventional power plants. Experimental data obtained at the U.S. Department of Energy's Coal Fired Flow Facility (CFFF), located at The University of Tennessee Space Institute near Tullahoma, TN, have verified the environmental performance of coal-fired MHD technology. The emissions levels for MHD shown in Figure 2 are actual test results from the CFFF. Sulfur dioxide emissions resulting from the combustion of high sulfur Illinois No. 6 coal (approximately 4% sulfur) were experimentally verified to be virtually nonexistent at a potassium-to-sulfur molar ratio of 1.5 in the MHD system. Emissions of nitrogen oxides ($NO_x$) were less than one-third of the New Source Performance Standards (NSPS) level. Particulate emissions were also well below the NSPS acceptable levels. Similar testing with the MHD system using Montana Rosebud coal as fuel resulted in experimental verification of emission levels of sulfur dioxide, nitrogen oxides, and particulate well below the limits prescribed by the NSPS for a western coal.

The environmental benefits from MHD utilization are substantial, and significantly, the price is right. Control of nitrogen oxides, carbon dioxide, and other secondary pollutants is essentially free since the reductions occur inherently in the process or result from the higher efficiency. MHD systems impose no additional economic or environmental penalty for particulate collection. The potassium seed required to reduce sulfur dioxide emissions from an MHD plant is essential for the operation of the MHD system. Since it is economically desirable to recover the potassium and regenerate new seed material, sulfur will be produced as a by-product of the seed regeneration process and provides a potentially marketable product producing income to the plant operation. Furthermore, conventional sulfur removal systems impose a performance penalty on a power plant because of the electrical power required to operate the system. For example, at the Ohio Edison Bruce Mansfield plant, a scrubber was installed at a cost of $500 million to reduce sulfur emissions. In 1986, the scrubber reportedly accounted for about one-half of the plant's operating expenses and consumed as much as seven percent of the facility's total electrical output. In comparison, a mature MHD system could virtually eliminate the sulfur emissions while significantly increasing the electrical output of the power plant by up to fifty percent.

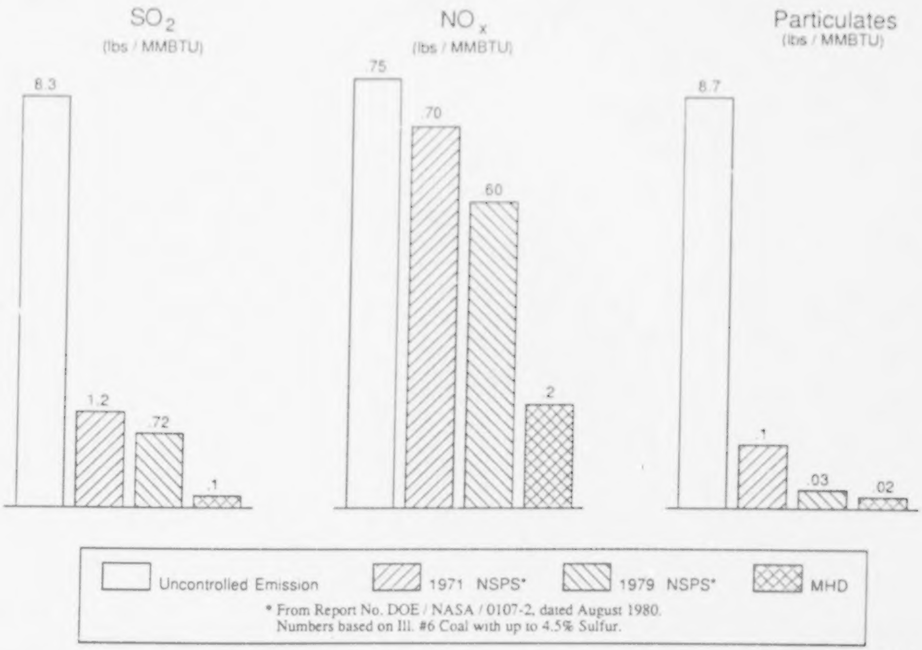
In 1985, fifty-seven percent of the electrical power generated in the United States was produced from coal-fired plants. If each of these coal-fired plants had utilized MHD power generation technology, up to eighty-six percent of the nation's electrical power requirements could have been supplied by the existing number of coal-fired power plants. The electrical power generated would be produced at a lower cost than for existing or planned conventional electric generating plants because of the higher efficiency. From a different perspective, a recent report from the Utility Data Institute, Inc. in Washington, D. C. forecast a potential shortage of 20 percent of capacity in electrical power generation in the 1990's. This projected demand in excess of capacity could be met with no new power plant construction if existing plants could be retrofitted with a mature MHD system.

While these benefits are sufficient to justify continued development of MHD technology, the outstanding advantage of MHD is the mitigation of environmentally-intrusive emissions. Aside from the increased electrical production, converting existing coal-fired plants to MHD would result in reducing the millions of tons of $SO_2$ currently emitted to the environment to virtually insignificant levels.

MHD is a developing 'clean coal technology' with substantial advantages for fossil-fueled electrical power generation. The significant environmental benefits have been experimentally verified. MHD technology is readily adaptable to retrofit existing coal-fired power plants in an environmentally acceptable manner. The United States is currently the world leader in coal-fired MHD technology, although efforts in many other nations are being accelerated. Continued development of coal-fired MHD technology will ensure the United States an efficient, clean, reliable electrical power source for the future utilizing our most abundant energy resource, coal. Clearly, MHD is the 'clean coal technology' choice for the future.

Figure 2.

## Emission Levels from Coal - Fired MHD Power Plant



* From Report No. DOE / NASA / 0107-2, dated August 1980.
Numbers based on Ill. #6 Coal with up to 4.5% Sulfur.

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The University of Tennessee Space Institute
Tullahoma, Tennessee